Central Queensland Coal Project

Chapter 9 – Surface Water

Central Queensland Coal

CQC SEIS, Version 3

October 2020

Contents

Figures

Tables

Terms and Abbreviations

µS/cm	Micro Siemens per centimetre
%	Percent
AEP	Annual exceedance probability
ALS	ALS Water Sciences Group
ANCOLD Inc.	Australian National Committee on Large Dams Incorporated
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
AR & R	Australian Rainfall and Runoff
ARI	Average Recurrence Interval
As	Arsenic
ASS	Acid sulfate soils
AWBM	Australian Water Balance Model
AWQG	Australian Water Quality Guidelines
BoM	Bureau of Meteorology
BTEXN	benzene, toluene, ethylbenzene, xylene, naphthalene
CHPP	Coal Handling and Preparation Plant
CQC	Central Queensland Coal Proprietary Limited
CSG	Coal seam gas
Cth	Commonwealth
DES	Queensland Department of Environment and Science
DEWS	(former) Department of Energy and Water Supply
DGV	Default Guideline Value(s)
dia	Diameter
DIWA	Directory of Important Wetlands in Australia
DNRME	Queensland Department of Natural Resources, Mines and Energy
DO	Dissolved oxygen
EA	Environmental Authority
EC	Electrical Conductivity
EHP	Department of Environment and Heritage Protection
EIS	Environmental Impact Statement
ELVIS	Elevation Information System
EP Act	Queensland *Environmental Protection Act 1994*
EP Regulation	Environmental Protection Regulation 2019
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EPP (Water and Wetland Biodiversity)	Environmental Protection (Water and Wetland Biodiversity) Policy 2019
ERA	Environmentally Relevant Activities(s)
ESC	Erosion and Sediment Control
ESCP	Erosion and Sediment Control Plan

EV	Environmental Value(s)
FBA	Fitzroy Basin Authority
FHA	Fish Habitat Area
FIA	Failure Impact Assessment
GBR	Great Barrier Reef
GBRMP	Great Barrier Reef Marine Park
GBRWHA	Great Barrier Reef World Heritage Area
GEH	General Environmental Harm
GIS	Geographic Information System
GL/a	Gigalitre (s) per year
ha	Hectare(s)
HAT	Highest astronomical tide
HEV	High ecological value
HH	Harm to Humans
IECA	International Erosion Control Association
IESC	Independent Expert Scientific Committee
kL/day	Kilolitre(s) per day
km	Kilometres
km^2	Square kilometre(s)
L	Litre(s)
L/ROM tonne	Litre(s) per run of mine tonne(s)
L/s	Litres per second
LiDAR	Light Detection and Ranging
LOR	Limit of Reporting
m	Metres
m/s	Metres per second
m^3/s	Cubic metres per second
mAHD	Metres Australian Height Datum
mg/L	Milligram (s) per litre
MHWS	Mean High Water Spring
MIA	Mine Infrastructure Area
ML	Mining Lease
ML	Mega Litres
ML/a	Megalitres per annum
ML/d	Megalitre (s) per day
MLA	Mine Lease Area
mm	Millimetre(s)
MNES	Matters of National Environment Significance
Mo	Molybdenum

MOV	Maximum Operating Volume
Mt	Megatonne(s)
MWMP	Mine Waste Management Plan
N/A	Not applicable
NDWI	Normalized Difference Water Index
NRM	Natural Resource Management
NWQMS	National Water Quality Management Strategy
NTU	Nephelometric Turbidity Unit
PAF	Potentially acid forming
PAH	Polynuclear aromatic hydrocarbons
PAR	Population at Risk
pH	Potential of Hydrogen
PMF	Probable Maximum Flood
PRCP	Progressive rehabilitation and closure plan
QA/QC	Quality assurance / quality control
QLD	Queensland
QWQG	Queensland Water Quality Guidelines
RCP	Representative Concentration Pathway
REMP	Receiving Environment Monitoring Program
ROM	Run of Mine
ROP	Resource Operations Plan
SD	Slightly disturbed
Se	Selenium
SEIS	Supplementary Environmental Impact Statement
SILO	Scientific Information for Land Owners
SO_4^{2-}	Sulfate
SSTV	Site-Specific Trigger Value(s)
t	Tonnes
t/ha/year	Tonnes per hectare per year
t/year	Tonnes per year
TARP	Trigger Action Response Plan(s)
TDS	Total dissolved solids
The Project	The Central Queensland Coal Project
TLF	Train Loadout Facility
TMR	Transport and Main Roads
ToR	Terms of Reference
TPH	Total petroleum hydrocarbons
TRH	Total recoverable hydrocarbons
TSS	Total suspended solids

V	Vanadium
W/m^2	Watt(s) per square metre
Water Act	*Water Act 2000*
WMP	Water Management Plan
WQO	Water Quality Objectives(s)
WRP	Water Resource Plan
WTP	Water Treatment Plant

9 Surface Water

9.1 Introduction

This chapter addresses the potential impacts on surface water resources from the construction and operation of the Central Queensland Coal (CQC) Project (the Project).

This Chapter has been rewritten since that presented in the Supplementary Environmental Impact Statement (SEIS) Version 2 to include recent work undertaken to assess changes to the Project layout and operations that have occurred since then, and to address comments by regulatory agencies on the SEIS v2. See Chapter 3 – Project Changes and Responses to Regulator Comments for the full description of Project changes since SEIS v2, and the responses to submissions received.

The chapter draws on several assessments, which have been prepared to address the requirements of the Terms of Reference (ToR) for the CQC Project (approved by the Department of Environment and Heritage Protection (EHP) on 4 August 2017) and the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) Information Guidelines for proponents preparing coal seam gas and large coal mining development proposals (Information Guidelines, dated May 2018) and associated explanatory notes. Primary assessments include:

- WRM Water and Environment (2020) 'Flood Study and Site Water Balance Technical Report' (Appendix A5b)
- Engeny Water Management (2020) 'Preliminary Dams Consequence Category Assessment' (Appendix A5e)
- Eco Logical Australia (2020) 'Technical Report - Investigations on Groundwater – Surface Water Interactions, Central Queensland Coal Project' (Appendix A6d)
- HydroAlgorithmics (2020) 'Numerical Groundwater Model and Groundwater Assessment Report, for the Central Queensland Coal Project Supplementary Environmental Impact Statement Version 3 – Responses to Submissions' (Appendix A6b) and
- Orange Environmental (2020) 'Surface Water Quality Technical Report' (Appendix A5a)
- Previous Environmental Impact Statement (EIS), SEIS v1 and SEIS v2 (CDM Smith 2018).

The findings of these studies are outlined in this chapter with reference to the requirements of the Project ToR and the relevant State (Queensland) and Commonwealth regulatory frameworks, as detailed in Section 9.1.3. Additional sources are referenced as needed throughout the chapter.

9.1.1 Environmental Objectives and Performance Outcomes

The environmental objectives and performance outcomes relevant to surface water are provided in Schedule 8, Part 3, Division 1 of the Environmental Protection Regulation 2019 (EP Regulation) and for water, water resources, flooding and regulated structures in Table 1 of the Project ToR. The overarching objective is to operate the Project in a way that protects the environmental values of surface waters.

9.1.1.1 Environmental Protection Regulation Objectives and Performance Outcomes

The environmental objective and performance objectives relating to surface water outlined in the EP Regulation are detailed below.

Environmental Objective

The activity will be operated in a way that protects environmental values of waters.

Performance Outcomes

1. There is no actual or potential discharges to waters of contaminants that may cause an adverse effect on an environmental value from the operation of the activity.
2. All of the following:
    a. the storage and handling of contaminants will include effective means of secondary containment to prevent or minimise releases to the environment from spillage or leaks
    b. contingency measures will prevent or minimise adverse effects on the environment due to unplanned releases or discharges of contaminants to water
    c. the activity will be managed so that stormwater contaminated by the activity that may cause an adverse effect on an environmental value will not leave the site without prior treatment
    d. the disturbance of any acid sulfate soil, or potential acid sulfate soil, will be managed to prevent or minimise adverse effects on environmental values
    e. acid producing rock will be managed to ensure that the production and release of acidic waste is prevented or minimised, including impacts during operation and after the environmental authority has been surrendered
    f. any discharge to water or a watercourse or wetland will be managed so that there will be no adverse effects due to the altering of existing flow regimes for water or a watercourse or wetland
    g. for a petroleum activity, the activity will be managed in a way that is consistent with the coal seam gas water management policy, including the prioritisation hierarchy for managing and using coal seam gas water and the prioritisation hierarchy for managing saline waste and
    h. the activity will be managed so that adverse effects on environmental values are prevented or minimised.

9.1.1.2 ToR Environmental Objectives and Outcomes Relevant to the Project

The environmental objectives and outcomes relevant to the project for water, water resources, flooding and regulated structures are provided below.

Water

- The activity will be operated in a way that protects environmental values of waters.
- The activity will be operated in a way that protects the environmental values of groundwater and any associated surface ecological systems.
- The activity will be managed in a way that prevents or minimises adverse effects on wetlands.

Water Resources

With regard to water resources, the project must meet the following objectives:

- Ensure equitable, sustainable and efficient use of water resources.
- Maintain environmental flows and water quality to support the long-term condition and viability of terrestrial, riverine, wetland, lacustrine, estuarine, coastal and marine ecosystems, in a way that maintains the ecological processes on which aquatic biota depend.
- Identify environmental values and establish pre-disturbance (baseline) water quality objectives (WQOs) for surface and groundwaters suitable for use as assessment criteria in accordance with appropriate national and state guidelines and policies.
- Maintainence of the stability of beds and banks of watercourses, and the shores of waterbodies, estuaries and the coast.
- Maintain supply to existing users of surface and groundwater resources, including during construction, operation and decommissioning of the project.

Flooding

- Ensure that the risk and potential adverse impacts from flooding are avoided, minimised or mitigated to protect people, property and the environment.

Regulated Structures

- The design of the facility permits the operation of the site, at which the activity is to be carried out, in accordance with best practice environmental management.
- The potential consequences of the failure of a regulated structure on human life and the environment require that the highest standards are used for their design, construction, operation, modification and decommissioning. The industry, government and the Australian National Committee on Large Dams Incorporated (ANCOLD Inc.) have published several guidelines, which should be used to further develop objectives and outcomes for individual projects and the regulated structures they involve.

9.1.2 Terms of Reference Addressed in this Chapter

Table 9-1 summarises the requirements from the ToR for the Project relevant to this chapter, and where in this chapter they are addressed.

Table 9-1: ToR cross reference

Terms of Reference	Section of the SEIS
8.3 Water Quality	
The assessment of water quality is considered a critical matter given the proximity of the Great Barrier Reef World Heritage Area, the presence of a wetland of national significance within the project area, and usage of water resources for grazing purposes in the area. Conduct impact assessment in accordance with the EHP's EIS information guideline—Water.	Noted The EIS information guideline – water is included in Section 9.1.3.7 and addressed within this Chapter for surface water
With reference to the Environmental Protection (Water) Policy 2009 and section 9 the EP Act, identify the environmental values of surface waters within the project area, downstream and upstream that may be affected by the project, including any human uses of the water and any cultural values.	Section 9.3.5

Terms of Reference	Section of the SEIS
Define and/or establish the relevant water quality objectives applicable to the environmental values, and demonstrate how these will be met by the project during construction, operation and decommissioning.	Sections 9.3.6.1 and 9.4.6
Quantify sediment and contaminant load increases to streams and to the reef as a result of mining operations.	Section 9.6.6
Detail the chemical, physical and biological characteristics of surface waters and groundwater within the area that may be affected by the project and at suitable reference locations using sufficient data to define background conditions and natural variation in accordance with appropriate national and state guidelines and policies.	Section 9.3.6
Describe the quantity, quality, location, duration and timing[1] of all potential and/or proposed releases of contaminants addressing applicable standards from any relevant regional water quality management plans, strategies, or guidelines relating to water quality. Releases may include controlled water discharges to surface water streams, uncontrolled discharges when the design capacity of storages is exceeded, spills of products during loading or transportation, spills of product from the conveyor, contaminated run-off from operational areas of the site (including seepage from waste rock dumps), or run-off from disturbed acid sulfate soils.	Sections 9.4, 9.5.5 and 9.5.6
Assess the likely impacts of any releases from point or diffuse sources on all relevant environmental values of the receiving environment, including environmentally sensitive areas; such as the Great Barrier Reef World Heritage Area and Broad Sound Directory of Important Wetlands in Australia (DIWA) nationally important wetland as well as near-field and mid-field locations. The assessment should consider the quality and hydrology of receiving waters and the assimilative capacity of the receiving environment.	Sections 9.5.5 and 9.5.6. Chapter 15 - Aquatic and Marine Ecology, Appendix A10f - Draft REMP
Describe how impacts on water quality objectives and environmental values would be avoided or minimised through the implementation of management strategies that comply with the management hierarchy and management intent of the Environmental Protection (Water) Policy 2009. Appropriate management strategies may include the use of erosion and sediment control practices, and the separation of clean storm water run-off from the run-off from disturbed and operational areas of the site.	Section 9.7
Describe how monitoring would be used to demonstrate that objectives were being assessed, audited and met. For example, provide measurable criteria, standards and/or indicators that will be used to assess the condition of the ecological values and health of surface water environments. Propose corrective actions to be used if objectives are not being met.	Section 9.7, particularly sub-section 9.7.7
8.4 Water Resources	
The assessment of surface water and groundwater resources is considered a critical matter given the usage of water resources for grazing purposes in the area. Conduct impact assessment in accordance with the EHP's EIS information guidelines—Water.	Noted The EIS information guideline – water is included in Section 9.1.3.7 and addressed within this Chapter for surface water

[1] Duration and timing are important aspects of the risk characteristics that affect the impacts of mine and CSG water releases; e.g. for how long will water be released in total and when will it occur with respect to existing 'natural' flows

Terms of Reference	Section of the SEIS
Describe present and potential users and uses of water in areas potentially affected by the project, including municipal, agricultural[2], industrial, recreational and environmental uses of water.	Section 9.3.8
Provide details of any proposed changes to, or use of, surface water or groundwater	Sections 9.4.2
Identify any approval or allocation that would be needed under the *Water Act 2000.*	Section 9.1.3.2, Section 9.4.2
Describe all aquifers that would be impacted by the Project, including the following information: • nature of the aquifer/s • geology/stratigraphy - such as alluvium, volcanic, metamorphic • aquifer type - such as confined, unconfined • depth to and thickness of the aquifers • groundwater quality and volume • current use of groundwater in the area • survey of existing groundwater supply facilities (e.g. bores, wells, or excavations) • information to be gathered for analysis to include: - location - pumping parameters - drawdown and recharge at normal pumping rates and - seasonal variations (if records exist) of groundwater levels	Chapter 10 - Groundwater
• proposal to develop network of groundwater monitoring bores before and after the commencement of the Project.	Chapter 10 - Groundwater
Include maps of suitable scale showing the location of diversions and other water-related infrastructure in relation to mining infrastructure.	Figure 9-34, Figure 9-35, Figure 9-36, Figure 9-37
Detail any significant diversion or interception of overland flow.	Section 9.4, particularly sub-section 9.4.3.5
Assess the potential impacts of any new water infrastructure (including diversions, pits, dams, etc.) and any proposed changes to water supply or take, on ground and surface water hydrology, quality and hydrological processes.	Section 9.6 Chapter 10 - Groundwater
Describe the options for supplying water to the Project and assess any potential consequential impacts in relation to the objectives of any water resource plan and resource operations plan that may apply.	Sections 9.4.2, 9.1.3.2 (no WRP or ROP applies)
Describe how 'make good' provisions would apply to any water users that may be adversely affected by the project.	Chapter 10 - Groundwater
Describe the proposed supply of potable water for the project, including temporary demands during the construction period.	Section 9.4.2
Also describe on-site storage and treatment requirements for waste water from accommodation and/or offices and workshops.	Section 9.4.3.8
Describe the practices and procedures that would be used to avoid or minimise impacts on water resources.	Section 9.7

[2] https://publications.qld.gov.au/dataset/daff-environmental-impact-assessment-companion-guide/resource/7b1825c4-5e42-4cf8-aa2d-7fa55c2f5e4c

Terms of Reference	Section of the SEIS
Quantify the volume of all takes from the groundwater system (including pit dewatering, degassing, etc.) and assess the impacts on groundwater levels, quality and ecosystem interactions for each aquifer and any implications for surface-groundwater interactions.	Chapter 10 - Groundwater
8.4.1 The Independent Expert Scientific Committee	
The EIS must include a specific section responding to the information requirements contained in the Independent Expect Scientific Committee's (IESC's) Information guidelines for proposals relating to the development of coal seam gas and large coal mines where there is a significant impact on water resources (Commonwealth of Australia 2015[3])	Section 9.12
8.5 Flooding	
The assessment of surface water and groundwater resources is considered a critical matter given the use of the area for cattle grazing and the need to protect the environmental values of water resources.	Noted
Describe current flood risk for a range of annual exceedance probabilities (AEPs) up to the Probable Maximum Flood (PMF) for the project site.	Section 9.3.4.4
Use flood modelling to assess how the project may potentially change flooding and run-off characteristics on-site and upstream and downstream of the site.	Section 9.6.1
Maps and plans showing inundated and flooded areas for the full range of AEPs up to the PMF flood should be presented for the site, for the case before construction of the project, and also after mine closure. The assessment should consider all infrastructure associated with the project including levees, roads, and linear infrastructure, and all proposed measures to avoid or minimise impacts.	Sections 9.3.4.4 and 9.6.1 include flood maps for relevant events (0.1% and 1% AEP). The full range is included in Appendix A5b
Evidence should be provided that the securing of storage containers of hazardous contaminants during flood events meets the requirements of Schedule 5, table 2 of the EP Regulation.	Discussed in Section 9.7.1 and 9.7.3 but addressed further in the emergency management plan, detailed in Chapter 21 Areas of high conservation value are described in Section 9.3.4, and Chapters 14 and 15
Describe and illustrate where any residual voids and mining features e.g. waste rock dumps would lie in relation to the extent of the PMF. Demonstrate that these features will not impact on the ecological functioning and physical processes of the floodplain and GBR in the longer-term.	Section 9.6.1 Chapters 11 - Rehabilitation and Decommissioning and 15 – Aquatic and Marine Ecology
Assess the project's vulnerabilities to climate change (e.g. changing patterns of rainfall, hydrology, temperature and extreme weather events).	Section 9.6.1.2 Chapter 4 – Climate and Climate Change
Describe possible adaptation strategies (preferred and alternative) based on climate change projections for the project.	Chapter 4 – Climate and Climate Change

[3] http://www.iesc.environment.gov.au/publications

Terms of Reference	Section of the SEIS
8.6 Regulated Structures	
Conduct impact assessments on regulated structures in accordance with the EHP's EIS information guideline—Regulated structures, EHP's Guideline on structures which are dams of levees constructed as part of environmentally relevant activities[4], and EHP's Manual for assessing hazard categories and hydraulic performance of structures[5].	Section 9.4.7, Appendix A5e The EIS information guideline – Regulated structures is included in Section 9.1.3.7
Describe the purpose of all dams or levees proposed on the project site.	Section 9.4.3 and Chapter 1 – Introduction and Project Description
Show their locations on appropriately scaled maps, and provide plans and cross-sections, illustrating such features as embankment heights, spillways, discharge points, design storage allowances, and maximum volumes.	Sections 9.4.3, 9.4.7 and Appendix 16 - Construction Design Drawings
Describe how storage structures and other infrastructure would be sited to avoid or minimise risks from flooding.	Section 9.6.1
Where project infrastructure comprises dams or other structures for storing potentially hazardous materials, undertake a consequence category assessment for each dam or levee, according to the criteria outlined in EHP's Manual for assessing consequence categories and hydraulic performance of structures. The assessment must be undertaken for the three different failure event scenarios described in EHP's manual, i.e. for seepage, overtopping and dam break. Regulated structures must comply with the Manual for assessing consequence categories and hydraulic performance of structures in accordance with Schedule 5, table 2 of the EP Regulation.	Section 9.4.7
Following the consequence category assessment, determine the consequence category ('low, significant, or high') according to table 1 of EHP's Manual for assessing hazard categories and hydraulic performance of structures and provide certified copies of these the consequence category determination for each of the proposed dams or levees.	Section 9.4.7 Appendix A5e contains a Preliminary Dams Consequence Category Assessment, prepared by Engeny Water Management. Full certification will be undertaken as part of the EA requirements during detailed design.
Describe how risks associated with dam or storage failure, seepage through the floor, embankments of the dams, and/or with overtopping of the structures will be avoided, minimised or mitigated to protect people, property and the environment.	Sections 9.7 and 9.4
8.8 Coastal Environment	

[4] http://www.ehp.qld.gov.au/assets/documents/regulation/era-gl-structures-dams-levees-eras.pdf
[5] https://www.ehp.qld.gov.au/assets/documents/regulation/era-mn-assessing-consequence-hydraulic-performance.pdf

Terms of Reference	Section of the SEIS
Conduct impact assessment in accordance with the EHP's EIS information guideline—Coastal.	Chapter 15 – Aquatic and Marine Ecology
Provide illustrated details of the existing coastal zone that is potentially affected by the project, and describe and illustrate any proposed works in the coastal zone, including a schedule of ongoing maintenance requirements. The description should at least address the following matters: • state or Commonwealth marine parks in the region of the project's site • separately mention marine plants and any fish habitat areas protected under the *Fisheries Act 1994*	No works proposed in the coastal zone
Assess the potential impacts of the project's activities in the coastal zone.	Chapter 15 – Aquatic and Marine Ecology
Propose measures to avoid or minimise the potential impacts of the project's activities in the coastal zone. If acid sulfate soils would be disturbed, describe measures to avoid oxidation of the sulfides or to treat and neutralise the acid if it forms.	Chapter 15 – Aquatic and Marine Ecology Chapter 5 – Land (note no ASS are likely to be disturbed)
Detail any residual impacts that cannot be avoided, and propose measures to offset the residual loss.	Chapter 15 – Aquatic and Marine Ecology
Develop and describe suitable indicators for measuring coastal resources and values, and set objectives to protect them in accordance with relevant State Planning Policy July 2014, guidelines and legislation. Refer to EHP's guidelines on coastal development.	Chapter 15 – Aquatic and Marine Ecology
Detail a monitoring program that would audit the success of mitigation measures, measure whether objectives have been met, and describe corrective actions to be used if monitoring shows that objectives are not being met.	Chapter 15 – Aquatic and Marine Ecology

9.1.3 Relevant Legislation and Guidelines

Chapter 2 outlines the regulatory framework relevant to the Project. Those that relate to surface water are:

- *Environmental Protection Act 1994* (EP Act)
  - Environmental Protection (Water and Wetland Biodiversity) Policy 2019 (EPP [Water and Wetland Biodiversity])
- *Water Act 2000* (Water Act)
- *Coastal Protection and Management Act 1995*
- *Fisheries Act 1994* and
- *Marine Parks Act 2004.*

In addition, due to the proximity of the Project to the coast and the Great Barrier Reef Marine Park (GBRMP) area, the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is potentially relevant to the project in terms of water quality.

The following sections provide a summary of the above legislation and how these pertain to the surface water aspects of the Project.

9.1.3.1 Environmental Protection Act 1994 (Qld)

The EP Act provides the key legislative framework for environmental management and protection in Queensland. The object of the EP Act is to 'Protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains ecological processes on which life depends' (s3).

The EP Act has a range of subordinate legislation, including the EP Regulation and EPP (Water and Wetland Biodiversity). The EP Regulation controls activities with potential to release contaminants into the environment (Environmentally Relevant Activities [ERAs]), contains referrable wetland requirements, prescribes water contaminants (Schedule 9) and sets Environmental Values (EVs) for wetlands (s 81A). The EP Act and EP Regulation regulate mining and associated ERAs through Environmental Authority (EA) conditions. These conditions provide a means to regulate surface water management for the Project.

With the passing of the Environmental Protection (Great Barrier Reef Protection Measures) and Other Legislation Amendment Bill 2019, the EP Act has been amended to address land-based sources of water pollution flowing to the Great Barrier Reef (GBR). The new 'Reef protection regulations' came into effect on 1 December 2019 and are to be rolled out over three years, including:

- new, expanded or intensified regulated industrial land use activities such as sewage and water treatment plants, land-based aquaculture or mining in any Reef region must meet new discharge standards to ensure there is no increase in nutrient or sediment pollutant loads from 1 June 2021 and
- other primary producer requirements, including compliance with industry specific minimum practice agricultural standards, farm nutrient budgets, environmental authorities for new or expanded cropping or horticulture.

The regulations apply to specific reef regions, with the Project being located in the Fitzroy reef region, in the Styx river basin (no. 127).

9.1.3.1.1 Environmental Protection (Water and Wetland Biodiversity) Policy 2019

The EPP (Water and Wetland Biodiversity) is subordinate legislation to the EP Act. It seeks to achieve the objectives set within the EP Act in relation to Queensland waterways. That is, it seeks to: 'Protect Queensland's waters while allowing for development that is ecologically sustainable' (s3 EP Act).

This purpose of this policy is achieved by:

- identifying EVs and management goals for Queensland waters
- stating water quality guidelines and water quality objectives to enhance or protect the EVs
- providing a framework for making consistent, equitable and informed decisions about Queensland waters and
- monitoring and reporting on the condition of Queensland waters.

The Styx River basin, including all waters of the basin, Broad Sound and adjacent coastal waters (basin 127 and adjacent to basin 127) are scheduled waters under Schedule 1 to the policy. EVs and WQOs are described for these waters in the document 'Styx River, Shoalwater Creek and Water Park Creek Basins Environmental Values and Water Quality Objectives' (EHP 2014a), made pursuant to the previous Environmental Protection (Water) Policy 2009.

The EVs and WQOs relevant to the Project for the Styx River, Shoalwater Creek and Water Park Creek Basins are described in Sections 9.3.5 and 9.3.6.1.

Scheduled WQOs for GBR catchment waters are also incorporated under s11(4) of the policy, specified in the document 'Great Barrier Reef River Basins End of Basin Load Water Quality Objectives' (DES 2019a). These are derived from the end of catchment anthropogenic water quality targets set under the 'Reef 2050 Water Quality Improvement Plan' (State of Queensland 2018).

9.1.3.2 Water Act 2000 (Qld) and Water Regulation 2016

The Water Act and Water Regulation 2016 provides a framework for the sustainable management of Queensland's water resources, primarily for the planning, protection, allocation and use of Queensland's surface waters and groundwater. Under section 808 of the Water Act, a person must not take, supply or interfere with water unless authorised under the Water Act for the taking of water from overland flow, groundwater, a watercourse, lake or spring comes via a water entitlement and a development application. All mining activities must be assessed and approved for the taking of produced water during operations.

Interrelated water resource plans, licenses and permits are provided under the Water Act to regulate groundwater and surface water use within each catchment. Currently, a water resource plan has not been established under the Water Act for the Styx Catchment in which the CQC Project resides.

The Act also provides for the identification of watercourses, including downstream limits of defined watercourses.

9.1.3.3 Fisheries Act 1994 (Qld)

The *Fisheries Act 1994* is the key piece of legislation regulating fishing, development in fisheries habitat areas, and damage to marine plants in Queensland. It regulates land-based activities that may damage declared Fish Habitat Areas (FHAs) and marine plants such as mangroves, with technical detail for mechanisms created by the act outlined in the Fisheries Regulation 2008 (Qld), including:

- closed waters and protected areas (e.g. Green Zones in the GBRMP) and
- protected species (e.g. dugongs).

The freshwaters in the region house habitat areas for some species of fish, including Barramundi and sea mullet, and a declared Fish Habitat Area (FHA-047) is located downstream of the site, terminating at the Styx River bridge at Ogmore.

Marine plants are also located downstream of the site, within the declared FHA.

9.1.3.4 Coastal Protection and Management Act 1995

The *Coastal Protection and Management Act 1995* seeks to provide for the protection and management of the 'coastal zone' and ensure development decisions are aligned with the potential threat from 'coastal hazards.' The Act defines the 'coastal zone', 'coastal management districts' and 'erosion prone areas.'

The Project lies adjacent to the coastal zone as currently mapped (see Chapter 15 – Aquatic and Marine Ecology), and areas of storm tide hazard and erosion prone areas are mapped in proximity to the site. The Coastal Management District is located at the confluence of the Deep and

Tooloombah Creeks (refer Section 9.3.4), approximately 2.3 km downstream from the Project area.

9.1.3.5 Marine Park Act

The *Marine Parks Act 2004* provides a framework for the conservation of the marine environment, including the monitoring and enforcing of compliance with the Act. The Marine Parks (Great Barrier Reef Coast) Zoning Plan 2004 (Schedule 2), under the Act, defines the General Use Zone at the mouth of the Styx River. This zone, at its nearest point, generally aligns with the Broad Sound FHA boundary located approximately 10 km downstream of the Project.

9.1.3.6 Environment Protection and Biodiversity Conservation Act 1999 (Cth)

The EPBC Act regulates:

- impacts on Matters of National Environmental Significance (MNES)
- impacts on the environment involving the Commonwealth or Commonwealth land
- killing or interfering with listed marine species and cetaceans (e.g. whales) and
- international trade in wildlife.

Importantly, the Act administers the approval for actions with a significant impact on MNES.

These, and actions by the Commonwealth or involving Commonwealth land with a significant impact on the environment are termed controlled actions and require approval under the Act.

The Project was identified as having the potential to impact on MNES and was determined to be a controlled action (EPBC ref 2016/7851) requiring assessment and approval under the EPBC Act. The controlling provisions are:

- World Heritage properties (sections 12 & 15A)
- National Heritage places (sections 15B & 15C)
- Listed threatened species and communities (sections 18 & 18A)
- Listed migratory species (sections 20 & 20A)
- Great Barrier Reef Marine Park (sections 24B & 24C) and
- a water resource, in relation to coal seam gas development and large coal mining development (section 24D & 24E).

In terms of water resources for the project, the World Heritage and GBRMP MNES are potentially triggered, as well as surface and groundwater resources potentially impacted by the Project. Based on the results of other assessments for the Project, it is not anticipated that downstream water quality will be affected by the mine to the extent that they can impact on the GBRMP and world heritage area.

9.1.3.7 Applicable Guidelines

The National Water Quality Management Strategy (NWQMS) presents the overarching national approach to improving and managing water quality in Australia’s waterways. The Australian and New Zealand Guidelines for Fresh and Marine Water quality (ANZG 2018) (hereafter the Australian Water Quality Guidelines, or AWQG) are a key part of the NWQMS and provide authoritative guidance on the management of water quality in Australia and New Zealand. The AWQGs are implemented through the Water Quality Management Framework - a framework providing a logical process to be followed for the long-term management of receiving water/sediment quality.

The AWQGs provide guidance on developing monitoring programs, selecting relevant indicators, and adopting relevant guideline values to assess change in receiving environments, including a framework for developing locally derived guidelines.

In Queensland, the approach to adopting guideline values for receiving waters is:

- EPP (Water and Wetland Biodiversity) scheduled EVs and WQOs, unless sufficient local data is available to derive improved local guideline values from appropriate reference sites
- end of catchment anthropogenic pollutant reduction targets in GBR catchments contained in the Great Barrier Reef River Basins, End-of-Basin Load Water Quality Objectives (DES 2019a), derived from the Reef 2050 Water Quality Improvement Plan 2017–2022 (State of Queensland 2018)
- Queensland water quality guidelines (EHP 2013) (QWQGs) in- the absence of EPP (Water and Wetland Biodiversity) scheduled values and
- AWQG Default guideline values.

The above existing default guideline values are referred to herein as default guideline values (DGVs), after the term used by the AWQGs.

As noted in Section 9.1.3.1.1, the Styx basin is scheduled under the EPP (Water and Wetland Biodiversity). The QWQGs provide regional guideline values for Queensland water types and regions, and approaches that complement the AWQGs for Queensland conditions, including a framework for deriving and applying local guideline values.

Water monitoring protocols are contained in the Queensland Monitoring and Sampling Manual (DES 2018).

This assessment has also been undertaken with reference to the following guideline documents:

- The DES 'EIS Information Guideline – Water' and 'EIS Information Guideline – Regulated structures'[6] and
- The 'Manual for Assessing Consequence Categories and Hydraulic Performance of Structures' (DES 2016).

9.1.4 Terminology

The following terms for water are used herein:

- Watercourse – A significant / high order defined drainage feature classified as such under the Water Act (see Section 9.3.4.2).
- Drainage feature – A minor tributary that flows only intermittently and for the duration of rainfall events.
- Waters – General term for a receiving body of water (creek, dam, pool etc.), usually used in the context of defining impacts due to changes in water quality.
- Water table aquifer - refers to an aquifer associated with the water table. In most parts of the Project Site and surrounds, this is the alluvial aquifer. However, in some locations, particularly at Tooloombah Creek, the creek channel intersects the deeper weathered Styx Coal Measures. The term 'water table aquifer' therefore refers to the aquifer associated with the water table, regardless of which geological layer the aquifer is located within.

[6] https://www.qld.gov.au/environment/pollution/management/eis-process/about-the-eis-process/developing-an-eis

- Bank storage - a temporary source of groundwater stored within the banks of creeks or rivers which is derived from infiltration associated with flooding or rainfall. Water held in bank storage may be released to the adjacent creek or river over varying timescales following the recession of surface water levels.

In discussing existing Default Guideline Values from the AWQGs, EPP (Water and Wetland Biodiversity), and the like, the term Default Guideline Values (DGVs) is used. For generating site specific criteria for further action, and to ensure clarity from existing DGVs, the term Site-Specific Trigger Values (SSTVs) have been used. This follows the use of the terminology in Queensland and the QWQGs.

9.2 Methods

The assessment of surface water impacts has been undertaken using a combination of desktop assessment, field sampling and statistical analysis, and the development of hydrologic, hydraulic and water balance models. Reports and data from the previous EIS and SEIS v1 and SEIS v2 were drawn upon, and the following specific studies were commissioned:

- RGS Environmental (2020a) 'Geochemical Assessment of Waste Rock and Coal Rejects' (Appendix 3b)
- RGS Environmental (2020b) Land Stability Assessment (Appendix 3c)
- Eco Logical Australia (2020) Groundwater Dependent Ecosystems, Aquatic Ecology, Marine Ecology and the Great Barrier Reef (Appendix A10a)
- Orange Environmental (2020) Surface Water Quality Technical Report (Appendix A5a)
- WRM Water and Environment (2020a) 'Flood Study and Site Water Balance Technical Report' (Appendix A5b)
- WRM Water and Environment (2020b) 'Draft Water Management Plan' (Appendix A5c)
- Fluvial Systems (2020) 'Supplementary Technical Study Report, Fluvial Geomorphology' (Appendix A5d)
- Engeny Water Management (2020a) 'Preliminary Dams Consequence Category Assessment' (Appendix A5e)
- HydroAlgorithmics (2020) 'Numerical Groundwater Model and Groundwater Assessment Report, for the Central Queensland Coal Project Supplementary Environmental Impact Statement Version 3 – Responses to Submissions' (Appendix A6b)
- Eco Logical Australia (2020) 'Receiving Environment Monitoring Program' (Appendix A10f)
- Engeny Water Management (2020b) 'Draft Erosion and Sediment Control Plan' (Appendix 15a) and
- Engeny Water Management (2020c) 'Styx Catchment Sediment Budget for the Great Barrier Reef' (Appendix 15b).

9.2.1 Desktop Assessment

A desktop review and assessment was conducted, involving analysis of available water quality data, database and relevant literature searches, aerial imagery and LiDAR data as outlined below. Additional literature review is incorporated into the technical reports and as cited in this Chapter.

Water Quality reports and guidelines

- Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018)
- 2017 Scientific Consensus Statement: Land Use Impacts on Great Barrier Reef Water Quality and Ecosystem Condition
- Model Water Conditions for Coal Mines in the Fitzroy Basin (DES 2013)
- Great Barrier Reef River Basins End-of-Basin Load Water Quality Objectives: Great Barrier Reef Basins 101–138 (excluding basins 115, 123, 131 and 139) (DES 2019a)
- Reef Water Quality Report Card 2017 and 2018 (DES 2019c)
- Styx River, Shoalwater Creek and Water Park Creek Basins Environmental Values and Water Quality Objectives (EHP 2014a) and
- Queensland Water Quality Guidelines (EHP 2013).

Available Data

- historical water quality data collected by the Fitzroy Basin Authority (FBA) between 2008 – 2012
- LiDAR elevation data collected in 2011 by CQC for the Project (3 x 3m grid), and data available from 2009 from the Intergovernmental Committee on Surveying and Mapping's Elevation Information System (ELVIS)
- aerial imagery captured during June 2011, along with the 2011 LiDAR data capture
- waterways, using the Queensland Government's *Watercourse lines – Queensland* (DNRME 2019) (these were confirmed as largely suitable as part of the Fluvial Geomorphology assessment (Appendix A5d)
- existing water users, from the Queensland Government's 'Water Entitlement Viewer' and
- other Geographic Information System (GIS) data, obtained from the Queensland Government's Spatial Catalogue – Qspatial, including FHA, GBRMP and GBR Coast Marine Park, World Heritage Area, NRM Region Land Use 2017, for example.

9.2.2 Field Surveys

9.2.2.1 Water Quality Sampling

Surface water quality monitoring data has been collected in the Styx River catchment since 2008, at the locations shown in Figure 9-1, and from the following sources:

- January 2008 to March 2012 – 21 discrete monitoring events by the FBA covering mostly storm events
- June 2011 to July 2012 – 12 approximately monthly events by CQC covering several storm events and otherwise mostly baseflow events and
- February 2017 to the present – 37 approximately monthly events by CQC up to 28 May 2020 (for the purposes of this assessment), predominantly 'no flow' events – that is, events with little to no discernible longitudinal flow along the creeks, due to the extended dry conditions.

Table 9-2 shows the number of events per site and the period of measurement, with those with greater than the QWQG recommended 18 events (excluding dry) highlighted blue, and those with greater than the AWQG recommended 24 measurable events (excluding dry) highlighted green.

The overall program has excellent coverage of the main Project site and lease area, with locations upstream and downstream. Sites with >24 sampling events are located along both Tooloombah and Deep Creeks, the confluence of both creeks and at the Ogmore Bridge, representing both upstream, adjacent and downstream reaches of these creeks in relation to the Project. Reference sites on Montrose and Granite Creeks have a good number of events recorded, close to the QWQG recommended 18 rounds.

While not a concurrent monthly program for the sites, the high number of events, many of which were on a monthly basis, make the data for the Tooloombah, Deep and Styx River sites likely to be quite suitable for deriving SSTVs.

Table 9-2: Number of samples per site by flow regime – main monitoring sites

System	Site	Period	*Dry*	No flow (pool)	Baseflow	Stormflow	Total (excl. dry)[1]
Deep Creek	De1	2011 – 2020	*18*	18	8	2	28
	De2	2011 – 2020	*9*	27	8	4	39
	De3	2011 – 2020	*13*	24	7	1	32
	De4	2017 – 2020	*4*	27	4	1	32
	De5	2017 – 2020	*2*	25	4	1	30
Tooloombah Creek	To1	2011 – 2020	*2*	30	14	4	48
	To2	2011 – 2020	*0*	28	12	1	41
	To3	2017 – 2020	*1*	27	4	0	31
	To4	2019 – 2020	*1*	3	1	2	6
Confluence	St1	2008 – 2020	*0*	23	17	22	62
Styx River	St2	2011 – 2020	N/A - tidal				44
Amity Creek	Am1	2011 – 2012 / 2019 - 2020	*3*	2	2	3	7
Barrack Creek	Ba1	2011 – 2020	*13*	1			1
	Ba1x	2017 – 2020	*2*		2		2
	Bar02	2020		1		2	3
Granite Creek	Gr1	2011 – 2012 / 2019 - 2020	*3*	5	8	4	17
Mamelon Creek	Mam01	2020		1	1	2	4
Montrose Creek	Mo1	2011 – 2012 / 2019 - 2020	2	5	9	3	17
	Mo2		1	8	6	4	18
Estuarine Sites - Styx, Waverley, St.Lawrence		Nov 2011	N/A - tidal				1
Dams	BPEast	2019 – 2020	N/A – no flow (dams)				3
	Ringtank	2019 – 2020					4
	Surveyors	2019 – 2020					7
Wetlands	Wet1	2020	N/A – no flow (wetlands)				5
	Wet2	2018 / 2020					6

Table notes:
1 Green identifies sites with total sample numbers (excluding dry events) greater than or equal to the AWQG recommended 24 data points. Blue indicates greater than or equal to the QWQG recommended 18 data points

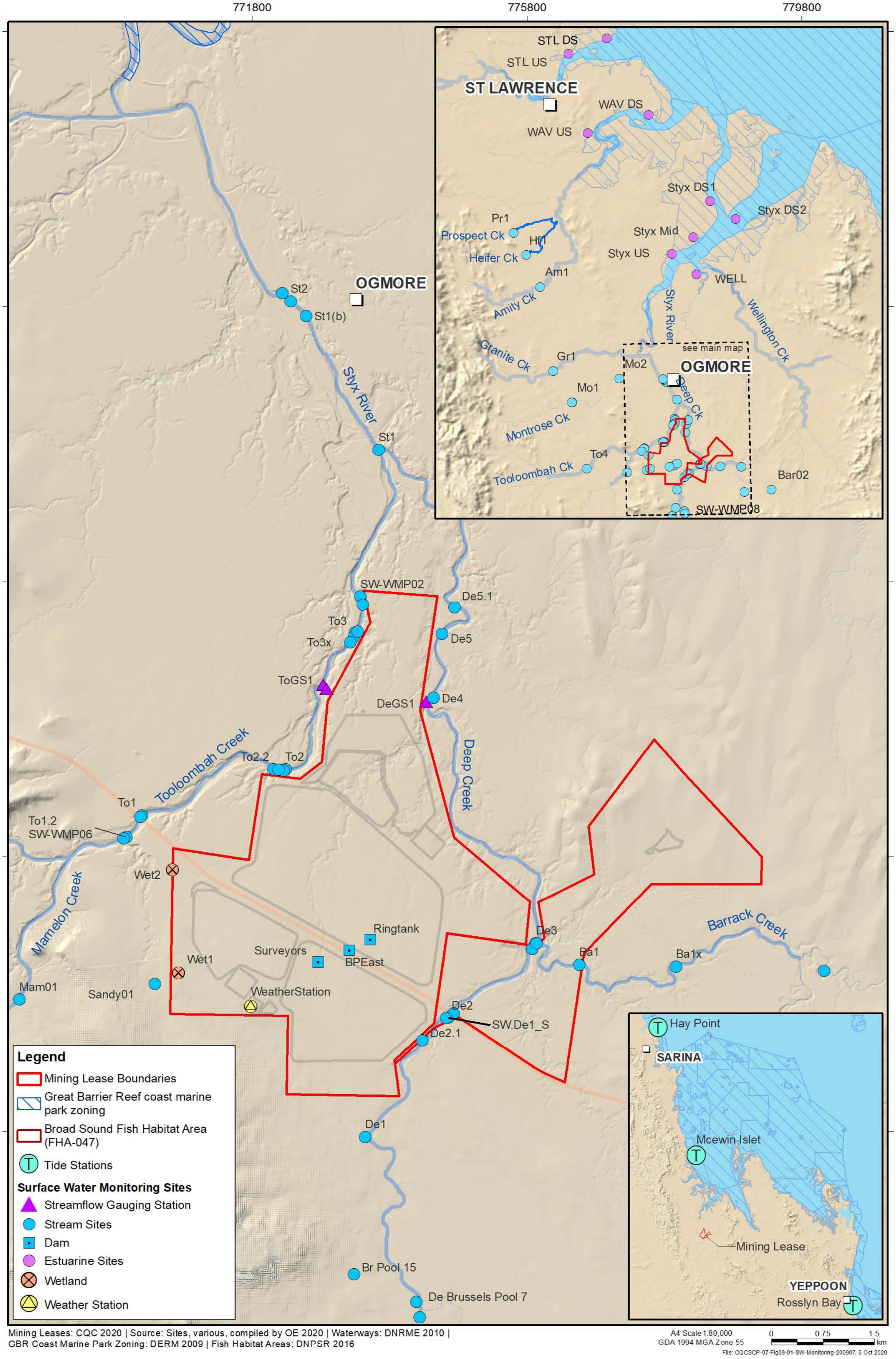

Figure 9-1: Surface water monitoring site

In-situ physical water quality measurements were taken while on site and water quality samples were collected for laboratory analysis. Field analysis of pH, dissolved oxygen, electrical conductivity (EC), turbidity and temperature were conducted, with water samples for laboratory analysis tested for the following parameters:

- physico-chemical
  - EC, total dissolved solids (TDS)
  - total suspended solids
  - alkalinity and
  - pH
- nutrients and major ions
  - sulfate, chloride, major cations (calcium, magnesium, potassium and sodium)
  - ammonia, nitrite, nitrate, oxidised nitrogen, total kjeldahl nitrogen and total nitrogen and
  - filterable reactive phosphorous, total phosphorous
- metals and metalloids
  - dissolved metals – aluminium, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, titanium, uranium, vanadium, zinc and
  - total metals – aluminium, arsenic, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, vanadium, zinc (only in 2020)
- hydrocarbons
  - total petroleum hydrocarbons (TPH) / total recoverable hydrocarbons (TRH)
  - polynuclear aromatic hydrocarbons (PAH) and
  - BTEXN – benzene, toluene, ethylbenzene, xylene, naphthalene.

All rounds included general physico-chemical parameters (pH, EC, TDS, etc.), with all but one including nutrients (this was for the purpose of radioisotope and fingerprinting of waters via major cations and anions). Cations and anions were included in all rounds other than the FBA monitoring. Radioisotopes were measured during one round (July 2018).

Dissolved metals were sampled in most rounds (96% of events), with total metals collected in only 9 (17%) of rounds. Hydrocarbons (TPH / TRH and BTEXN) were sampled on 60% of rounds, mostly from 2017 to the end of 2019, with PAHs and phenolic compounds added in 2019 (a full suite was also conducted in November 2011). The full suite of metals were analysed in 2011/2012, which was reduced in later years, dropping antimony, beryllium, boron, strontium, thallium, silver and titanium - these were generally below the Limit of Reporting (LOR), and either below the guideline value or had no guideline value, other than for silver (<LOR, but >guideline value).

Water samples were collected in general accordance with the Queensland Government's 'Monitoring and Sampling Manual' (DES 2018, and earlier versions EHP 2009 and DERM 2010). An assessment of laboratory documentation and quality assurance/ quality control (QA/QC) samples indicated generally low levels of holding time breaches or similar errors and overall minimal error in laboratory testing and sample handling.

Further details on the sampling and testing procedures, sites sampled and QA/QC assessment are provided in the Surface Water Quality Technical Report in Appendix A5a.

9.2.2.2 Pool Assessments

The water quality sampling program included sites at pools within the creeks sampled. Additional pools in the study area were targeted for identification and description, water quality testing, and for three pools, measurement of level and salinity on a two-daily basis as follows:

- 20 May to 25 September 2019: The pool at the To2 sampling site in Tooloombah Creek was tested every 2-days, with level recorded against a fixed measuring point (star picket), and EC recorded.
- 20 May to 8 July 2019: The pool at the De2 sampling site in Deep Creek was tested every 2-days, with level recorded against a fixed measuring point (star picket), and EC recorded. Monitoring stopped as the pool dried out
- 20 June to 8 July 2019: The pool at the De3 sampling site in Deep Creek was tested every 2-days, with level recorded against a fixed measuring point (star picket), and EC recorded. Monitoring stopped as the pool dried out.
- A number of pools within Deep and Tooloombah Creeks in proximity to the Project were visited in June 2017, and again in January – February 2018 with details such as pool length, width, and depth, along with field water quality (and for some systems laboratory data).
- A field visit was conducted from 25 – 28 May 2020, and again from 1 – 6 June 2020 to visit a number of pools identified from aerial imagery, and find additional pools along both Deep and Tooloombah Creeks. Pool width, depth and surface area, along with field water quality (and for some systems laboratory data) was collected. This was undertaken to support the work presented in the Groundwater Dependent Ecosystems, Aquatic Ecology, Marine Ecology and the Great Barrier Reef technical report in Appendix A10a.

9.2.2.3 Flow Measurement

Flow was generally recorded either as an indicative flow speed (m/s), or as a dry, no flow, slow, medium, fast range of criteria. This has been used to derive flow categories for each sample event, namely:

- Dry – no water (unable to sample).
- No flow – water can be sampled, but no flow is evident. At times, a no flow recording was change to baseflow based on other evidence.
- Baseflow – flow evident at the sample location, but evidence and timing indicates baseflow rather than stormflow runoff.
- Stormflow – using indications from sample sheets, proximity to rainfall events and the results of flow modelling.

Data is beginning to become available from the streamflow gauging stations on Deep and Tooloombah Creeks, and can be used to guide the above categories going forward.

Flow categories were used to assess bias in the data and in setting baseflow / stormflow statistics, as well as in assisting with the ephemeral classification of the systems.

9.2.2.4 Sediment Sampling

ALS Water Sciences Group (ALS) undertook estuarine and sediment sampling in November 2011 (provided in Appendix A10i). No sediment sampling has since been conducted.

The SEIS v2 committed to assessing sediments at each of the water quality monitoring locations prior to the commencement of construction activities, to be detailed in the Receiving Environment Monitoring Program (REMP). This commitment is reaffirmed in the current SEIS v3, and is incorporated into the draft REMP included in Appendix A10f. This will enable the collection of a suitable baseline dataset for comparison with post-development sediment quality.

9.2.2.5 Other sampling

Macroinvertebrates, fish and aquatic reptiles and platypus along with physical habitat assessments have been assessed as part of the aquatic ecology assessment, presented in Chapter 15 – Aquatic and Marine Ecology.

9.2.3 Water Quality Data Analysis

Water quality data have been collated into a database (along with groundwater data), coded with a confidence value to indicate potential issues, and further investigated to ensure only reliable data were included. For the derivation of medians and guideline value statistics, measurements taken close together at the same sites were combined into a single value by averaging, to ensure reasonably independent events were utilised (results less than 2 weeks apart was used as the cut off).

Statistics were generated from the data using the methods outlined in the Surface Water Quality Technical Report in Appendix A5a, grouped by flow category. A separate set of statistics was considered for each of the flow categories, and compared to derive general water quality flow characteristics. Given the large amount of data and the fact it is quite representative of most site conditions, the baseflow + no-flow (pools) grouped category was used primarily in determining guideline values.

9.2.4 Flood Modelling

Flood modelling was presented in the EIS and previous SEISs, and required updating as part of this SEIS v3. WRM Water and Environment prepared an updated hydrologic, hydraulic and 2D flood model over the Project area, with the methodology detailed in the Flood study and site water balance technical report provided in Appendix A5b. The approach taken and methods used are summarised below.

The hydrologic and hydraulic modelling in this SEIS has been conducted in terms of Annual Exceedance Probability (AEP) as is recommended by industry with the recent implementation of Australia Runoff and Rainfall 2016 (Ball et al. 2016). The change in terminology comes from a common misinterpretation of Average Recurrence Interval (ARI) terminology, in which it is erroneously assumed that a 1 in 10 year ARI, for example, will only occur exactly once in every ten years.

The AEP better handles this by describing the probability of a magnitude flood event being exceeded in any given year as a percentage probability. However, there are some guidelines and analyses that have not adopted the AEP definition, which ultimately means that the design standard for environmental dams, diversion drains and culverts are still established in terms of ARI. The relationship between AEP and ARI is as follows: 9.5% AEP (10 year ARI), 4.9% AEP (20 year ARI), 2% AEP (50 year ARI), 1% AEP (100 year ARI) and 0.1% AEP (1,000 year ARI).

Hydrological Modelling

A hydrological model was developed of the study area using the XPRafts runoff-routing model to estimate the 10%, 5%, 2%, 1% and 0.1% AEP peak design discharges[7], as well as the probable maximum flood (PMF) discharge. The model was based on design rainfall data (rainfall depths, areal reduction factors and temporal patterns) applied in accordance with ensemble event procedures in Australian Rainfall & Runoff (AR&R) (Ball et al. 2019).

The XPRafts model was developed over the area of the Styx River catchment draining to approximately 5 km downstream of the Project, with a catchment area of 717 km^2. Design discharges for the above events were determined and the model validated showing that the XPRafts model design discharges provide a conservative (high) estimate of design discharges.

Hydraulic Modelling

The TUFLOW hydraulic model was used to simulate flood behaviour in the study area including flood extents, depths and velocities. The model configuration extends past the upstream boundary of the mining lease area along Tooloombah and Deep creeks and approximately three kilometres downstream of the confluence of Tooloombah and Deep creeks, with an overall size of approximately 11 x 15 km, and based on the 3 x 3m LiDAR data captured for the site in 2011.

The hydrograph outputs from the XPRafts model were used as inflow boundaries, and the downstream boundary located on the Styx River approximately 5 km downstream of the Project. Hydraulic resistance (Manning's 'n' values) were selected based on mapping of vegetation areas from aerial photographs.

Ten sets of culvert crossings along the Bruce Highway were included in the model, based on details from the Transport and Main Roads (TMR) database. The Bruce Highway bridge crossings across Deep and Tooloombah Creeks were also modelled as layered flow constrictions based upon design drawings from TMR. Hydraulic parameters and losses for the culvert and bridge deck and piers were based on generally accepted modelling parameters.

The hydraulic model extent and location of inflow and outflow boundaries, culverts and bridges are shown in Figure 9-2.

The TUFLOW hydraulic model was used to assess flood impacts for the 10%, 5%, 2%, 1% and 0.1% AEP events for the existing and early phase developed conditions (up to Year 10, the first half of project life prior to commencement of Open Cut 1, represented by Year 8) for water depth and velocity. The 1% AEP event was modelled for late phase developed conditions (after year 10, including both open cut pits, represented by Year 11/12).

Climate Change Assessment

A sensitivity scenario for climate change was undertaken for the 1% AEP event based on the RCP8.5[8] scenario for 2100. This scenario represents a 20% increase in rainfall intensity. However, given the Project timeframes, this level of increase would not be expected to be realised during the Project lifetime.

---

[7] These relate to the 1 in 10 year, 1 in 20 year, 1 in 50 year, 1 in 100 year, and 1 in 1000 year ARI events, respectively

[8] Representative Concentration Pathway (RCP) 8.5 represents a warming scenario used by climate change modellers with little curbing of emissions – i.e. the high emissions scenario - leading to radiative forcing levels of >8.5 W/m^2 by the end of the century (IPCC 2014)

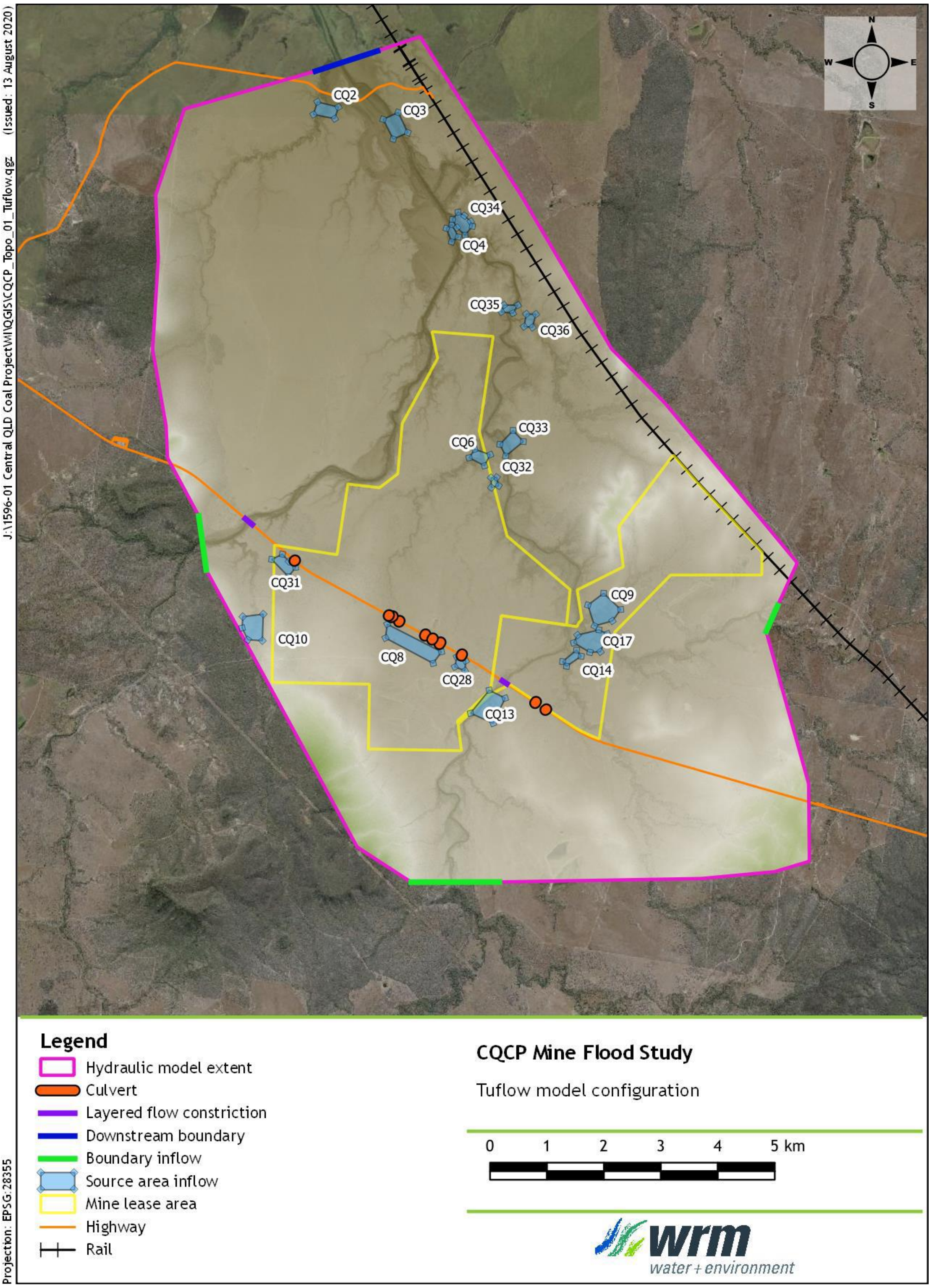

Figure 9-2: 2D Flood model (TUFLOW) configuration

9.2.5 Water Balance Modelling

A water balance model was developed by WRM Water and Environment within the OPSIM software to simulate the proposed site water management system, fine tune the operating volume of the site dams (with only Dam 1 having an operating volume, all others operated as empty and pumping to Dam 1), develop controlled release rules, and determine the flow and water quality impacts.

A rainfall runoff model was developed for the Deep and Tooloombah Creek catchments using the Australian Water Balance Model (AWBM). Initial model parameters were selected based on experience with other projects in the region. These parameters were then adjusted based on validation of the model results against a nearby catchment, and validated against recorded streamflow data for Tooloombah Creek.

Long term daily rainfall and evaporation data for the area from January 1889 to December 2019 (131 years) was obtained from the SILO climate database. Morton's Lake evaporation was used to estimate evaporation losses from storages.

The model used the above rainfall-runoff model as one of the inputs, and the Project and derived water management system configuration (including dam sizes) as the others. The water balance model was run on a daily time step for an 18-year period, corresponding to the period of operation between 2021 and 2038, adopting five project stages – Stages 1 to 5, represented by Project Years 3, 8, 11, 13 and 17 respectively. It was used to assess:

- mine affected water inventory
- pit inundation characteristics
- controlled releases
- uncontrolled spillway discharges and
- external water requirements.

Details of the adopted model parameters, model configuration and site storage characteristics are provided in Appendix A5b.

9.2.6 Streamflow and pools assessment

The rainfall-runoff model was used to simulate long term flows in both Creeks over the 131 year period of historical rainfall data (1889-2019). Catchment excision (reduction in catchments) and capture of runoff water on-site was used in the water balance model to estimate the total flow before and after Project commencement, both within the creeks, and for five identified wetland areas in proximity to the Project. For the assessment, Project releases were assumed to be zero.

An assessment was also undertaken of the Tooloombah Creek pool at the streamflow gauge site, which had seen relatively high increases in salinity in the dry season with low inflows, to determine whether the observed change in water level and salinity was driven by evaporation alone, or whether other processes, such as sub-surface inflow or outflow were affecting the pool water balance. This involved use of water level and salinity recorded continuously from the gauge in a simple daily water balance of the pool in OPSIM, with surface area, pool volume and evaporation rates estimated from aerial imagery and local conditions.

The potential impact of the project on the pool was investigated by using several changes to the estimated groundwater inflow / outflow rates, in consideration of the predicted worst case baseflow reduction / enhanced leakage rates from the numerical groundwater modelling (Chapter 10 – Groundwater, and Appendix A6b - Numerical Groundwater Model and Groundwater Assessment Report).

Additional assessments of several other pools were incorporated along with the above Tooloombah Creek pool into the Surface Water/Groundwater Interactions Report in Appendix A6d, which aimed to investigate other pools in a similar manner (varying inflow rates and salinities), to determine whether pool conditions could be explained by evapotranspiration alone, or whether an external water source (groundwater or bank flow return) was needed to explain the observed conditions.

To support this assessment, surveys of existing pools were conducted as described in Section 9.2.2.2 coupled with satellite imagery analysis. This used Quickbird satellite imagery from June 2011 to determine presence and size of pools, using 2.4 x 2.4 m pan sharpened Normalized Difference Vegetation Index (NDVI) imagery (prepared by the provider). This was followed up with further analysis using multi-band 6 x 6 m pan sharpened SPOT 6 satellite imagery, from 29 April 2018, and 13 September 2018. The NDVI and the colour imagery itself was used to identify areas of water, and the size of the pools that could be seen from the imagery. The Normalized Difference Water Index (NDWI) was also interrogated for the SPOT 6 imagery and compared with the NDVI and colour imagery to assist in identifying further pool areas.

Importantly, due to tree cover and the size of some pools, the satellite imagery approach was useful in identifying the presence or absence of larger pools, but was not able to confirm the presence or absence of many of the smaller pools, particularly within Deep Creek.

Further information on this assessment is provided in the Surface Water Quality Technical Report in Appendix A5a, the Surface Water/Groundwater Interactions Report in Appendix A6d, and Flood Study and Site Water Balance Technical Report in Appendix A5b.

9.2.7 Water Quality Modelling

The water balance model was used to derive water quality concentrations in site dams, releases and in downstream waters, adopting the following six parameters as indicators of water quality:

- Electrical conductivity (EC)
- Arsenic (As)
- Molybdenum (Mo)
- Selenium (Se)
- Sulfate (SO_4^{2-}) and
- Vanadium (V).

EC and sulfate are commonly adopted as indicators of potential water quality impacts due to coal mining. The remaining parameters (As, Mo, Se and V) were selected based on the findings of the SEIS geochemical assessment (Chapter 8 – Waste Rock and Rejects) which indicated that leachate may contain elevated concentrations of these parameters.

Each runoff type was assigned a concentration for each parameter that has been based on the available historical water quality monitoring data, as well as additional information provided as part of the geochemical assessment (detailed in Appendix A3b).

9.3 Description of Existing Environment

9.3.1 Climate

The Project region experiences a sub-tropical climate, with cool winters and hot summers. Mean winter (July) temperatures range between around 8 and 25°C, whilst mean summer (December-January) temperatures range between around 23 and 33°C.

The Project area experiences a distinct wet season with more rainfall occurring during the summer months (December to March), and drier periods predominating in the winter and early spring months (June to September). The wet season experiences an increased number of storm events leading to relatively short-lived but intense rainfall events and cyclonic rain depressions can develop over the area. The average annual rainfall at Strathmuir (BoM Station 033189) is 759 mm, with the highest average rainfall month (143 mm) being February and the lowest average rainfall month (16 mm) being September (Figure 9-3). Recharge and stream runoff potential is highest during the summer months, when most rainfall occurs, although long lasting rainfall events at other times of the year could also give rise to sustained rates of recharge.

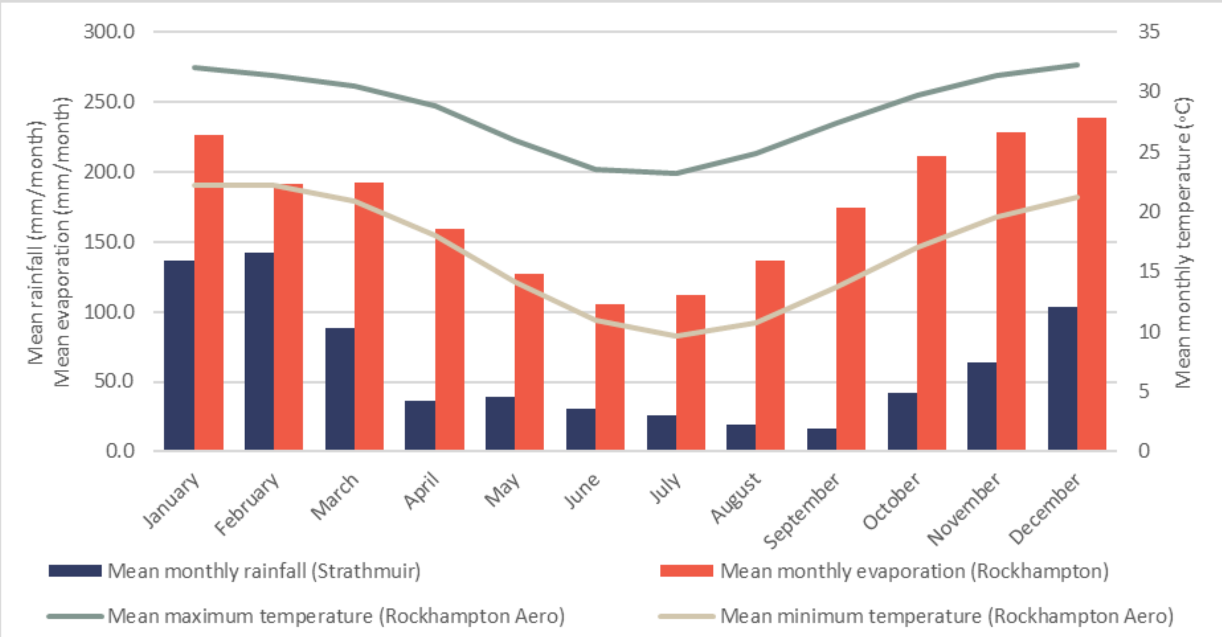

Figure 9-3: Mean climatic conditions

The mean monthly evaporation (calculated from the long-term average daily evaporation at Rockhampton Aero (BoM Station 039083) ranges from a maximum of around 240 mm/month in the summer months to a minimum of around 105 mm/month in the winter months. Total average annual evaporation (around 2,100 mm) is considerably higher than average annual rainfall, and on average evaporation rates exceed rainfall rates in every month of the year (Figure 9-3).

Cumulative deviation from mean rainfall is the accumulated difference between actual rainfall (e.g. in a month or a year) and the long-term mean, providing an indication of the general climatic trend over time as well as general water availability (soil water, surface water and groundwater). A cumulative deviation from mean plot of monthly rainfall at Strathmuir (BoM Station 033189) from January 1941 to October 2018 is presented in Figure 9-4.

The plot indicates that climate (rainfall) variability is typical of the Project area, with periods of:

- above average rainfall occurring from 1950 to 1955 and from 1973 to around 1980, and from 2010 to 2013
- below average rainfall occurring from approximately 1957 to 1971 and from 1991 to 2009 and
- around average rainfall occurring from 1940 to 1950, from 1978 to 1990 and from 2014 to present.

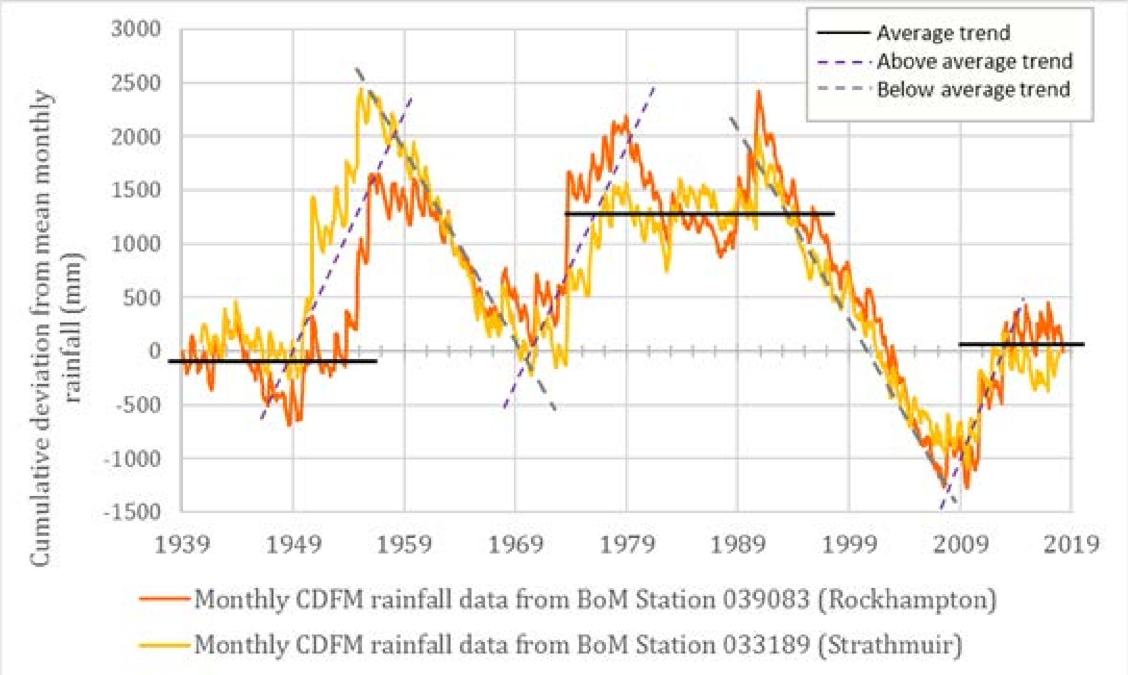

Figure 9-4: Cumulative deviation from mean monthly rainfall from BoM Station 033189 (Strathmuir) and 039083 (Rockhampton Aero)

9.3.1.1 Comparison Between Data Sources

The water balance and streamflow assessment presented in Appendix A5b utilised SILO gridded data. A comparison with rainfall station data gathered from the nearby Strathmuir rainfall gauge was prepared to assess its validity, and the Strathmuir rain gauge (033189) was selected due to its 76-year data record and proximity (within 8 km) to the Project site. A comparison of mean monthly rainfall values between the Strathmuir rain gauge and SILO data is presented in Figure 9-5. The graph indicates good agreement between gauge records and data acquired through SILO.

9.3.1.2 Rainfall during water sampling events

Figure 9-6 shows the actual rainfall for the November to May period (which covers wet season events) and full years versus the long-term average annual rainfall from the BOM Strathmuir rainfall gauge (BOM station 033189, prior to 2011, and from the Mamelon weather station (after July 2011, with some infill rainfall from the St. Lawrence Post Office station (BOM station 033065, March, June 2011; May – June 2017).

As can be seen, the FBA monitoring specifically targeted high rainfall events, while the other monitoring by CQC covered a range of rainfall periods, from above average (2011, 2017) to well below average (2018, 2019). Most of the data available covers the 2011 – 2020 period, which includes a good range of wetter and drier years.

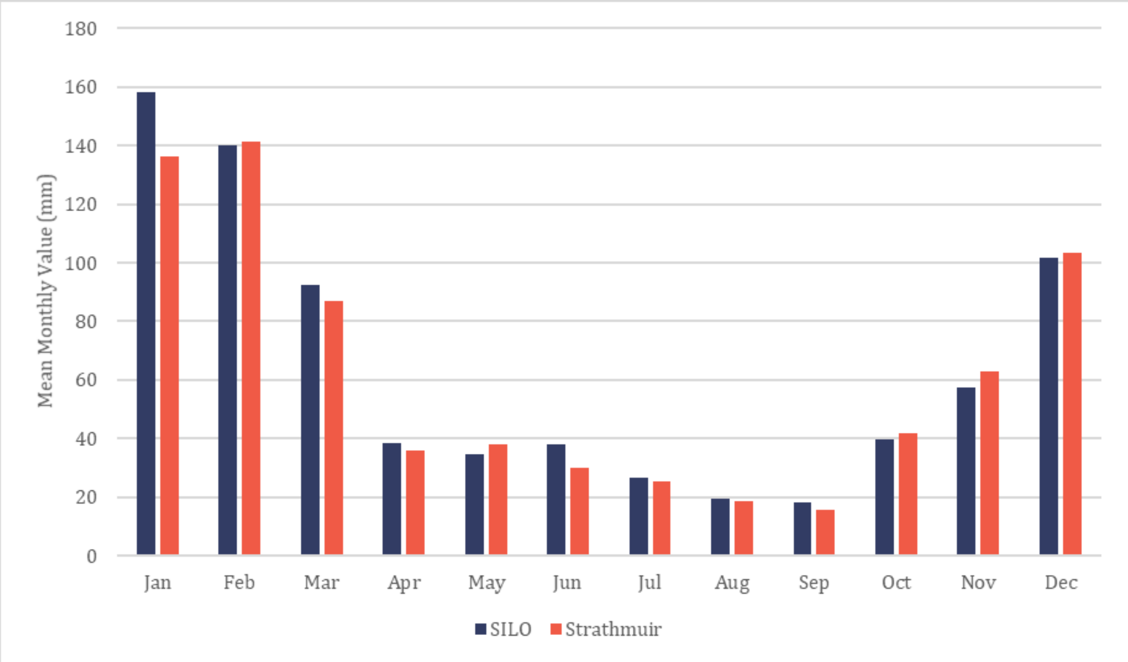

Figure 9-5: Comparison of SILO data to gauge data

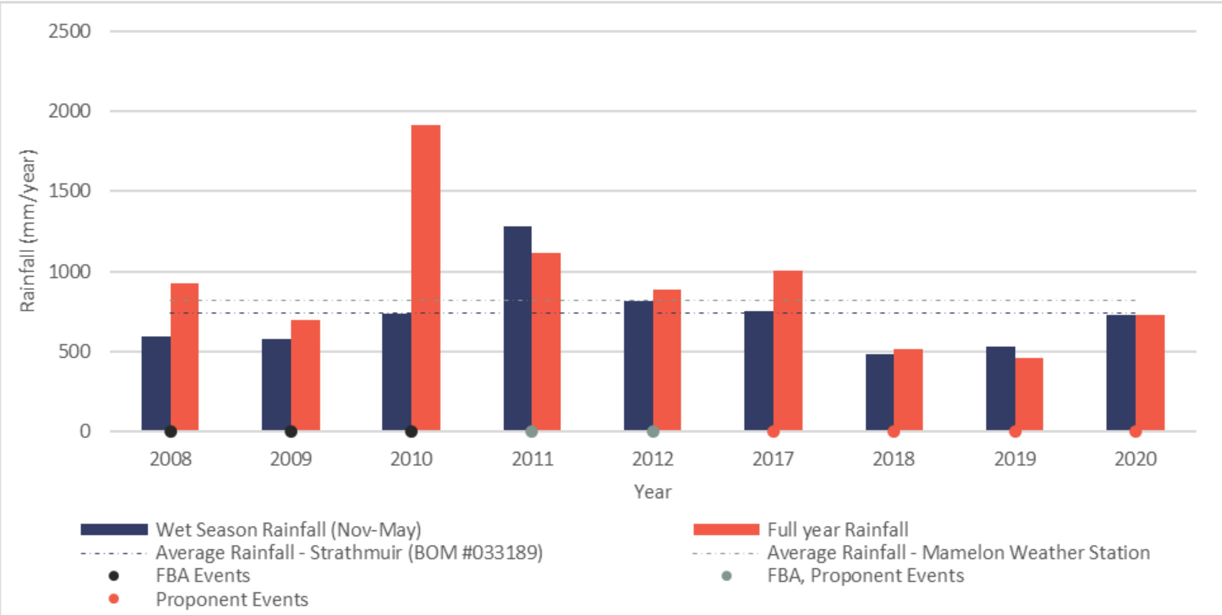

Figure 9-6: Average vs actual annual rainfall - sampling

9.3.2 Topography

The Project lies within the Styx River catchment of the larger Styx River Basin, which has elevations ranging from 540 mAHD (metres Australian Height Datum) along the western catchment boundary to sea level at the coast. Topography at the Project can be described as floodplains that are generally flat or undulating land draining via several smaller creeks and tributaries to the Styx River and estuary with elevations ranging between around 10 and 155 mAHD.

A detailed description of the topographic setting of the Project is provided in Chapter 5 – Land.

9.3.3 Geology

The geology of the Styx River catchment is characterised as Holocene sediments in the estuary and in the floodplain of some watercourses and local drainages, with large areas of Quaternary alluvial deposits overlying the early Cretaceous Styx Coal Measures, comprising quartzose, calcareous, lithic and pebbly sandstones, pebbly conglomerate, siltstone, carbonaceous shale and coal. The Styx Coal Measures overly a progression of Late Carboniferous to Late Permian deposits. Alluvial lithological units Qpa (Pleistocene) and Qa (Holocene) dominate the CQC Project area with Holocene Qh sediments also occurring in the estuary.

The regional and local geology is detailed in Chapter 5 – Land.

9.3.4 Hydrology

9.3.4.1 Styx Basin

The Project is located within the North East Coast Drainage Division, within the Styx River basin (Queensland river basin 127), a small basin of around 3,000 km^2 discharging into the Broad Sound and Coral Sea (refer Figure 9-7). The Styx River, the main waterway of the basin, discharges to the GBRMP, with the General Use Zone located approximately 40 km downstream of the Mining Lease (ML) area (refer Figure 9-8).

The basin has an estimated annual average discharge (for all rivers) of 271 GL/a (Dougall et al. 2014), and is formed by the Connors and Broadsound Ranges to the west, within the Central Queensland Coast region.

No Water Plan is in force over the basin.

Landuse in the basin is predominantly ‘Production from relatively natural environments’ (91%) – predominantly grazing - followed by ‘Conservation and natural environments’ (8%) and ‘Intensive uses’ (1%) which comprise transport and communication, residential and farm infrastructure, services and mining (DES 2019b). The remainder is predominantly water (saline coastal wetland areas, rivers and dams), with minor areas of dryland and irrigated agriculture (0.5%). The Styx basin has been extensively cleared for grazing.

A land condition survey conducted by Melzer et al. (2008) found the catchment to be degraded, noting that around 30% of the Styx catchment was highly to very highly disturbed, generally represented by bare ground and eroded surfaces. The study noted several points in the catchment where ‘erosion and land degradation must be considered severe’. The land condition survey noted that these most likely represent significant point sources of sediment to the streams, and places threats to road infrastructure. Seven very severe and six severe cases were identified where there was direct discharge to streams. Assessments of the Deep and Tooloombah Creek catchments carried out more recently identified areas of potentially severe erosion with a number of gullies identified as potential sources of high sediment loads (Appendix A5d - Supplementary Technical Study Report, Fluvial Geomorphology).

The Fitzroy Basin Association Natural Resource Management (NRM) body reports the most significant risk to the entire GBRMP is sediment. Approximately 1.95 million tonnes of sediment is deposited each year into the reef from the catchments within the NRM body (Waterhouse et al. 2015), with the largest source of in-stream sediment within the Fitzroy Catchment attributed to grazing land (Bartley et al. 2017).

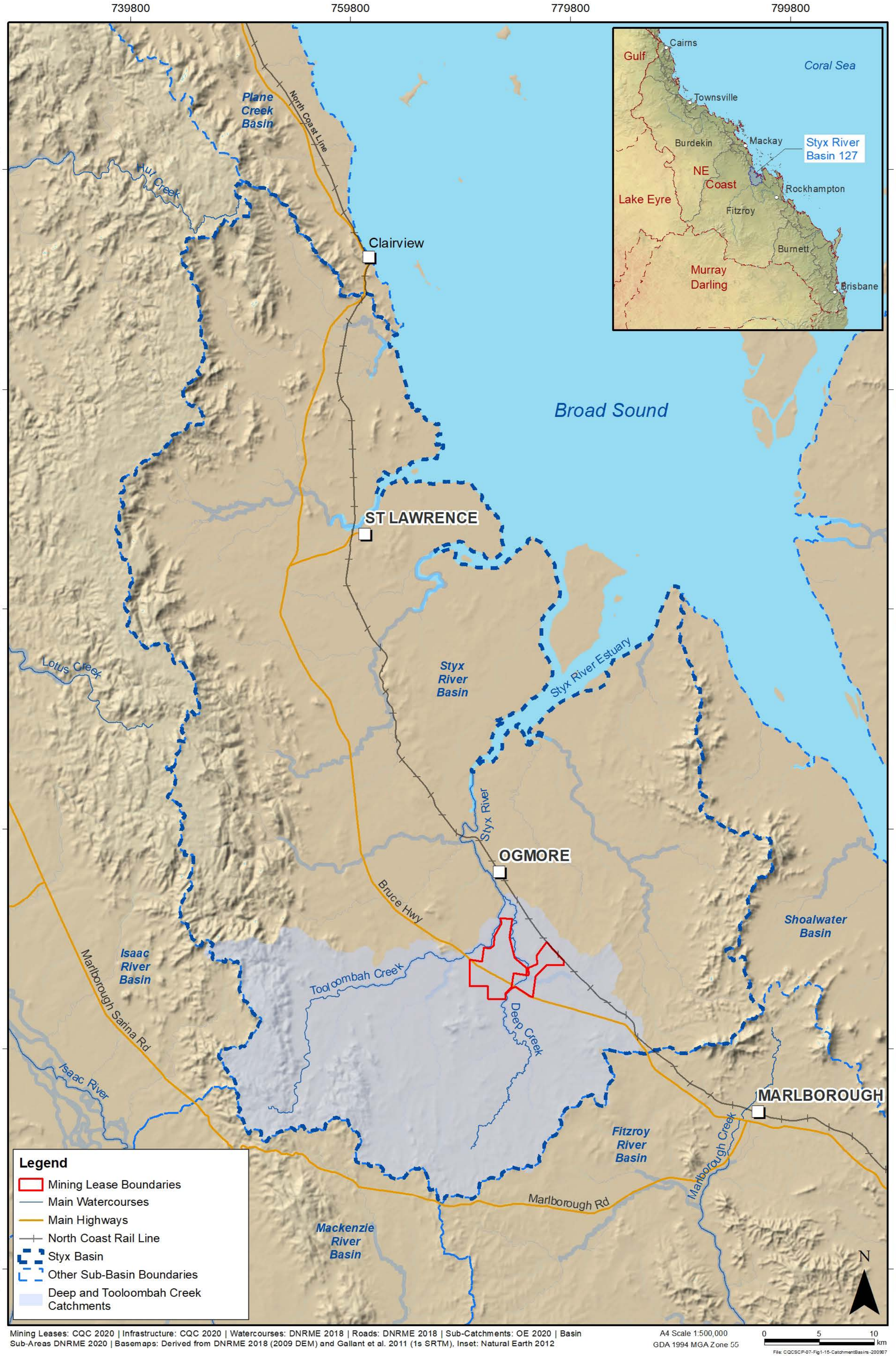

Figure 9-7: Surface water catchments

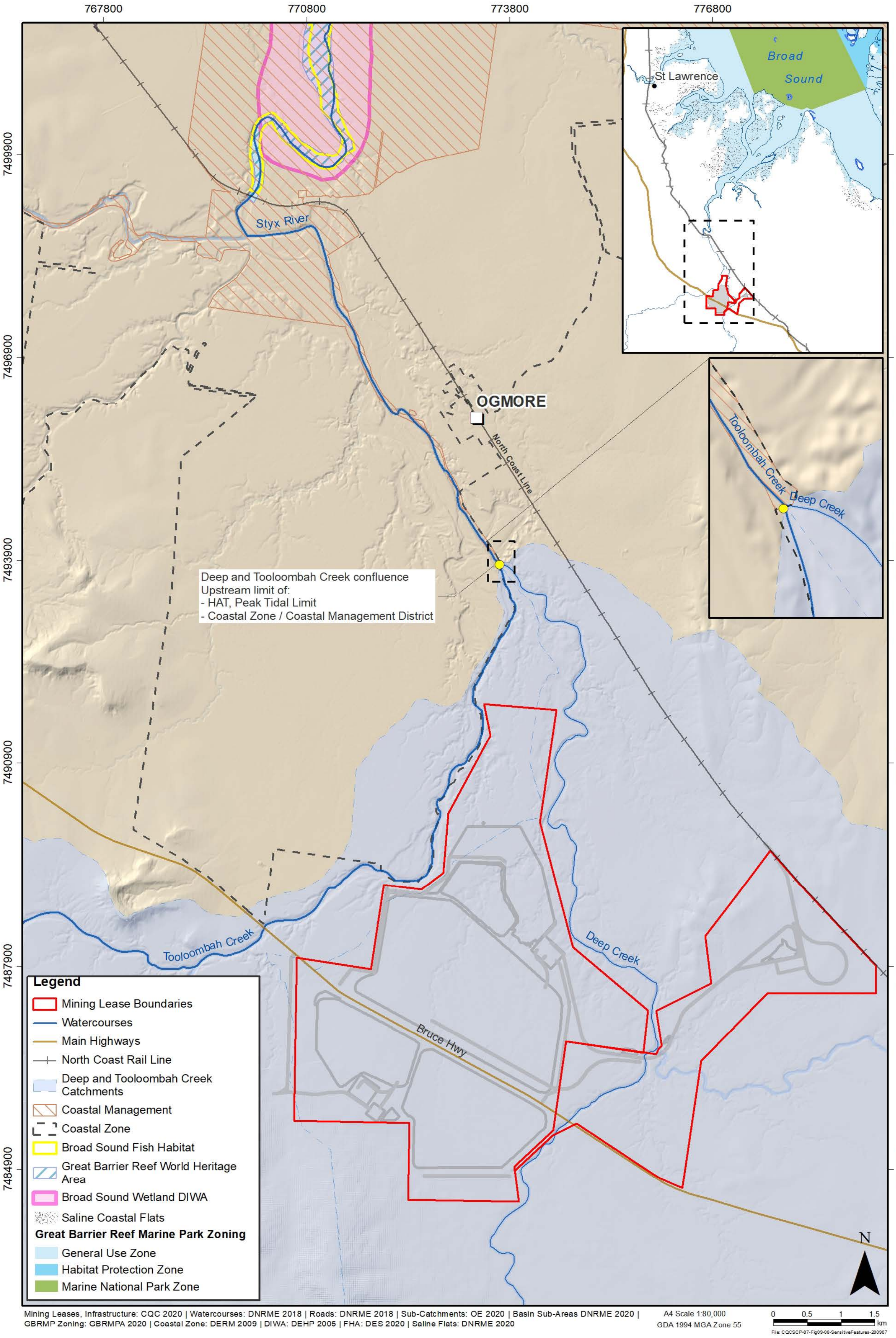

Figure 9-8: Downstream sensitive areas

The 2017 Scientific Consensus Statement - A synthesis of the science of land-based water quality impacts on the Great Barrier Reef, presents a modelled total suspended sediment load exported to the coast for the Styx catchment of 0.3 t/ha/year (refer to the Styx Catchment Sediment Budget for the Great Barrier Reef report in Appendix A15b).

The most recent catchment condition assessment related to water quality for the Styx basin is included in the Reef Water Quality Report Card 2017 and 2018 (DES 2019c). The results against the three target areas were as follows:

- Water quality targets - minimal anthropogenic dissolved inorganic nitrogen, particulate nitrogen and phosphorous and sediment loads, against a target of *Maintain Current Loads*, with the target for minimal pesticide risk met.
- Catchment management targets - groundcover and natural wetlands (lakes, swamps and estuarine wetlands) extent were both provided a B grade (89% area with target cover against a 90% target, <0.1% loss against a no loss target respectively), with riparian extent receiving a D grade, for 0.97% loss (with a no loss target). Groundcover does appear to be reducing over time (from 97% in 2010), but this may be a result of lower rainfall trends.
- Land management targets - grazing was graded a D, with 29.4% adoption of best management practice systems for water quality outcomes (soil, nutrient and pesticides), against a target of 90%. This was based on:
    - gully management (20.7% adoption, grade E)
    - pasture management (26.7% adoption, grade D) and
    - streambank management (40.9% adoption, grade D).

The Styx sub-basin comprises several coastal catchments, grouped into three overarching areas (after the EPP [Water and Wetland Biodiversity]), namely:

- Northern Styx Freshwaters
    - Clairview, St Lawrence, Waverley and Amity Creeks
- Styx River, St Lawrence, Waverley and other creeks (estuarine reaches):
    - Estuarine coastal areas mostly north of the Styx River and Broad Sound Estuaries, but including a strip along the southern shore of the Styx River and Broad Sound Estuaries and
- Southern Styx Freshwaters
    - Granite and Montrose Creeks
    - Tooloombah and Deep Creeks and
    - Styx River and Wellington Creeks.

The location of the Project in relation to these catchments and waterways are shown in Figure 9-7 and Figure 9-9.

9.3.4.2 Local Drainage Network

The Project is bounded by the Styx River's major tributaries, Tooloombah Creek to the west and Deep Creek to the east, but is located predominantly within the Deep Creek sub-catchment, within the Southern Styx Freshwaters EPP (Water and Wetland Biodiversity) catchment area. Both creeks are defined as watercourses under the Water Act.

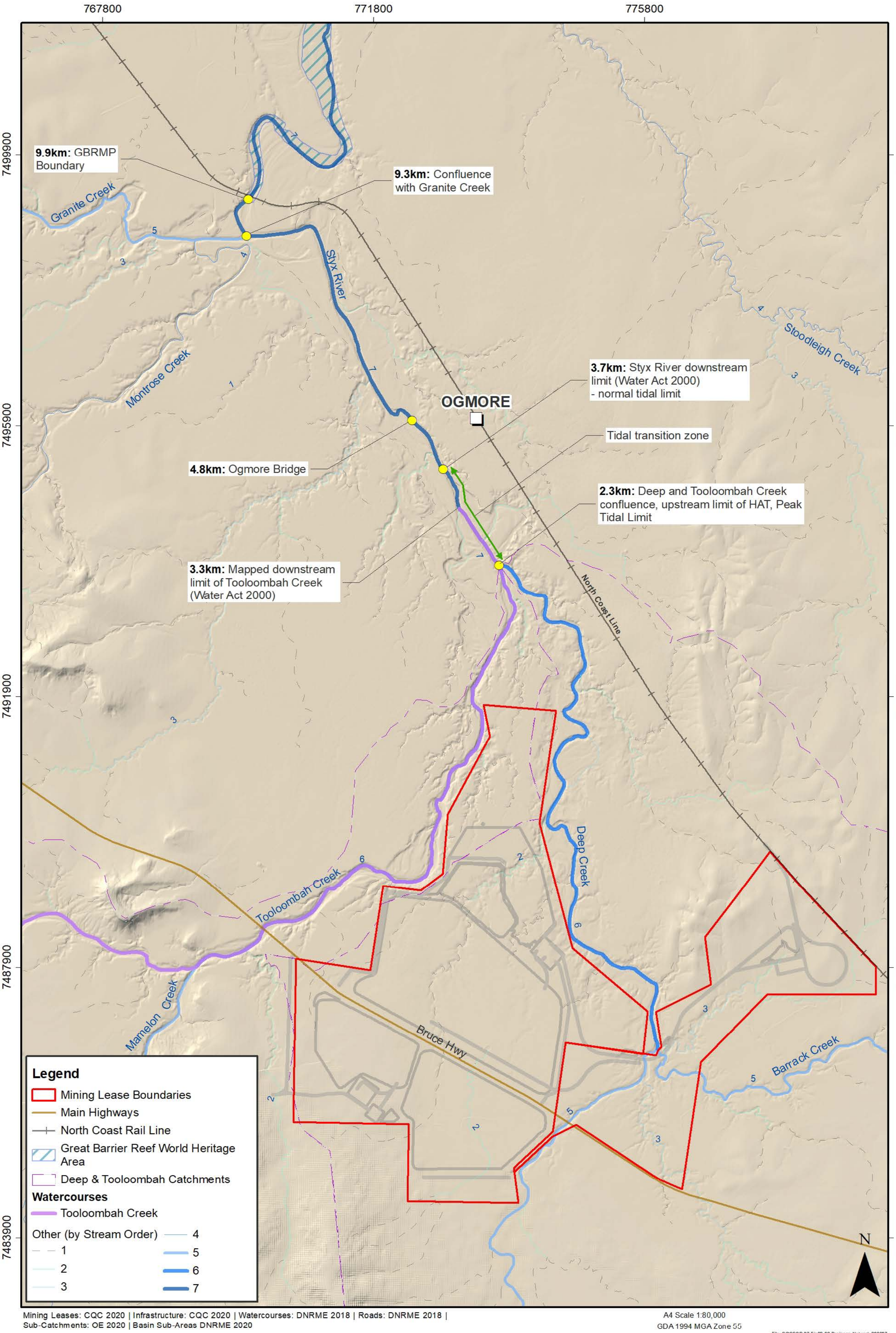

Figure 9-9: Drainage network

Deep Creek joins into Tooloombah Creek approximately 2.3 km downstream from the Project (the Deep and Tooloombah Creek confluence), with the downstream limit of Tooloombah Creek mapped under the Water Act a further 1 km downstream, where it becomes the Styx River. The downstream limit of the Styx River is defined under the Water Act another 1.4 km further downstream from the confluence of Deep and Tooloombah Creeks (3.7 km downstream from the Project). Below the confluence of Deep and Tooloombah Creeks other local tributaries join the Styx River, including Granite and Montrose Creeks (around 7 km downstream from the confluence).

Refer to Figure 9-9 for the location of these features.

The upper reaches of Tooloombah and Deep creeks extend west to the Broadsound Range which is characterised by steep topography with grades of approximately 10%. They are largely uncleared, and water is transported in well defined, often deeply incised channels. The middle portion of the sub-catchments have largely been cleared for dryland agriculture (grazing and very limited cropping) where topography flattens out, although most of the incised creek channels of Tooloombah and Deep creeks remain well vegetated. During extreme rainfall events, tributaries and the main channel overflow onto the floodplain. The middle portion of the catchment is prone to surface erosion, with several deeply incised erosional channels present, caused by surface flows during storm events.

The majority of the lower reaches of the catchment where the Project is located are characterised by generally flat terrain with slopes less than 0.5%. The main watercourses are deeply incised, with Tooloombah Creek channel significantly larger than the Deep Creek channel.

The lower part of the Styx River catchment is characterised by coastal and estuarine conditions, with the Styx River becoming tidally influenced downstream of the confluence of Deep and Tooloombah Creeks (refer to Section 9.3.4.2.4 for a discussion of the tidal limits in the Styx River). The Styx River discharges to the Styx River Estuary approximately 8 km downstream of the Project, to the Broad Sound approximately 32 km further downstream (Figure 9-8). The Broad Sound estuary is listed in the Directory of Important Wetlands of Australia (DIWA).

The Broad Sound Declared Fish Habitat Area (FHA-047) and a General Use Zone of the GBRMP are located within the Styx River approximately 10 km downstream of the Project lease boundary (refer Figure 9-8 and Figure 9-9).

Both Deep Creek and Tooloombah Creek are located outside the mine lease area (MLA), but the Project Site occurs within their catchments. Several small tributary drainages to Deep Creek and Tooloombah Creek traverse the Project Site but these are minor in nature, ranked as either first or second order drainage features and are classified as ephemeral, having intermittent flows.

Both Deep and Tooloombah creeks are ephemeral waterways, and flow for approximately 24% of the time, predominantly during the wet season (refer to the Flood Study and Site Water Balance Technical Report in Appendix A5b). At other times, the creeks are dry or form a series of disconnected pools, which gradually reduce in size over time, due to evaporation. Some pools are fed by groundwater from the water table aquifers and bank storage return water, resulting in their persistence during the dry season.

WRM (Appendix A5b) undertook an assessment of natural catchment runoff in Tooloombah and Deep Creek catchments, with flow duration curves shown in Figure 9-10 and Figure 9-11 respectively, each calculated at the creek flow gauging stations (ToGS1 and DeGS1 respectively).

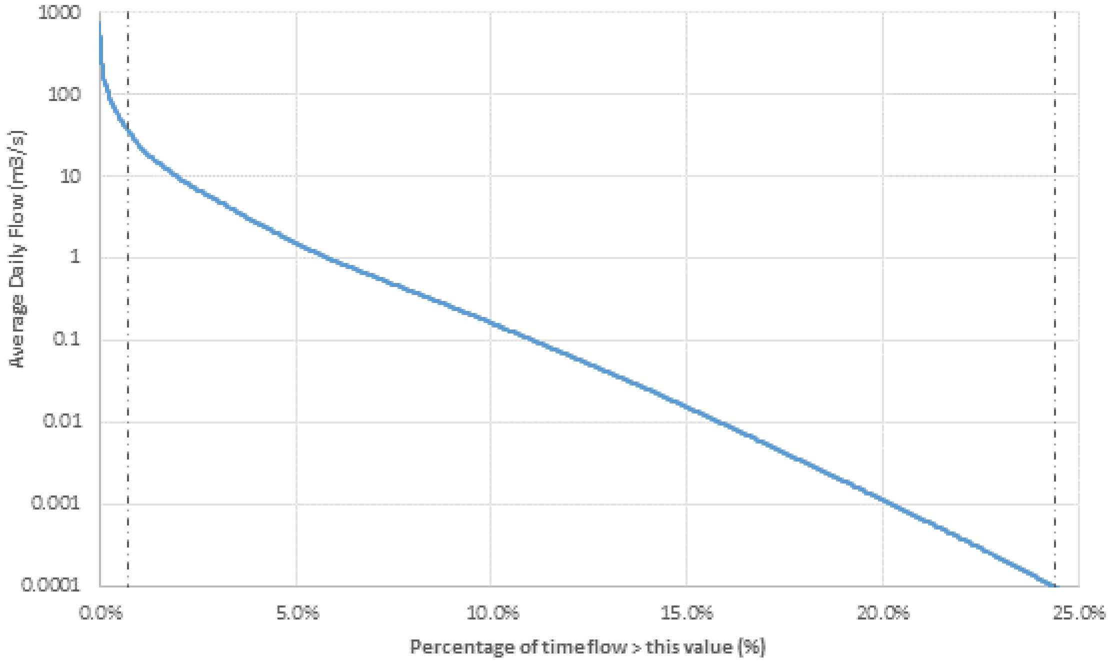

Figure 9-10: Tooloombah Creek simulated flow duration curve (after WRM 2020)

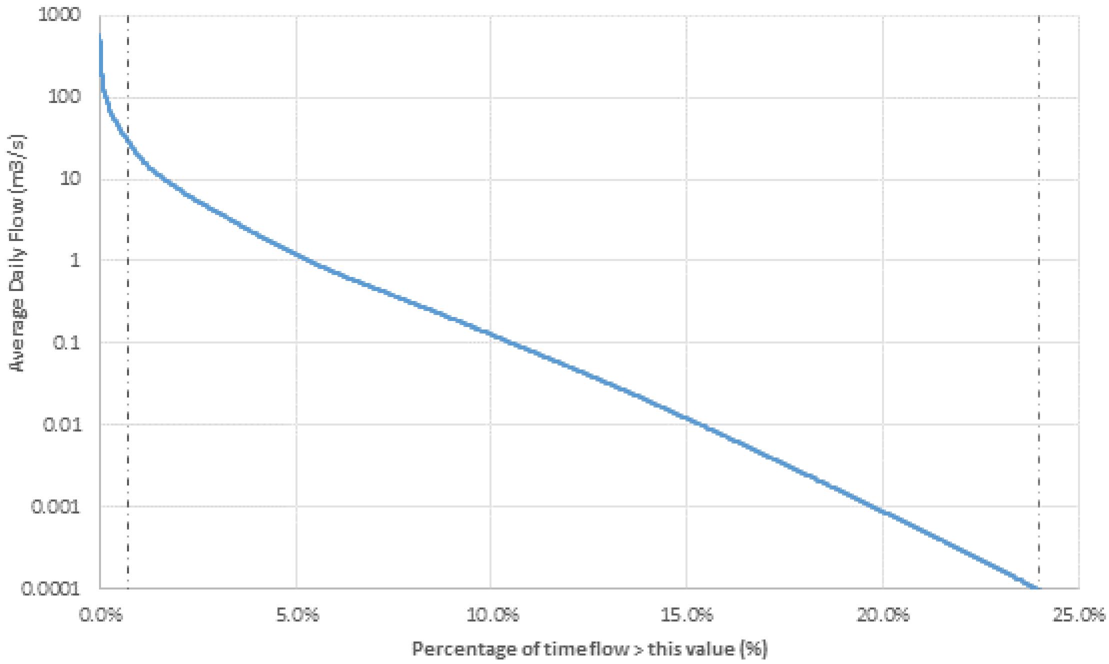

Figure 9-11: Deep Creek simulated flow duration curve (after WRM 2020)

These include indicative flow regimes based on the QWQG guidance (Section 2.5, EHP 2013) and the modelled runoff data as follows:

- Both Creeks are highly ephemeral, with flow approximately 24% of the time (flow above 0.1L/s).
- Stormflows account for <1% of flows, with stormflows typically above 30-40 m^3/s for Deep and Tooloombah Creeks respectively.

- Flow modelling indicates storm flows persist for 1 - 2 days, at times 3 days after an event (due to compounded rainfall). Based on turbidity levels recorded during storm event sampling by the FBA from 2008 - 2012, levels reduce after a peak over 1 - 2 days, matching the modelled flow data and qualitatively that found from field observations.
- Baseflows account for the bulk of flow events, at approximately 23% of flows between 0.1L/s and 30-40 m^3/s.
- Baseflows persist for around 1 – 3 months after a single stormflow event, depending on size and duration, averaging around 2 months.

9.3.4.2.1 Deep Creek

The tributary headwaters of Deep Creek occur to the south of the Project, at elevations around 90 to 180 mAHD. The creek runs in a northerly direction along the boundary between ML 80187 and ML 700022 before joining Tooloombah Creek 2.3 km downstream of the Project, with a total catchment area of 303 km^2. There is limited streamflow monitoring data available for Deep Creek; however, the creek is classified as a minor, non-perennial creek (BoM 2011). It is a 5th order stream upstream of the Barrack Creek confluence, becoming a 6th order stream until it's confluence with Tooloombah Creek. Modelling of the creek flows indicate an annual average flow in the order of 29 GL/a, and median of 10 GL/a (data from WRM Water and Environment, from rainfall runoff model presented in the Flood Study and Site Water Balance Technical Report in Appendix A5b).

Deep Creek reaches approximately 8 -10 m depth (top of bank to creek bed), with a width that ranges from 2 to 3 m upstream to 5 to 10 m downstream of the Project. The creek bed is comprised of silts, clays and sand with minimal aquatic vegetation. Deep Creek is highly responsive to rainfall, with sharp rises in stream height and turbidity during rainfall events. Anecdotal evidence suggests large seasonal flow events are around 4 m deep and can persist for several days only.

The Deep Creek surface water is generally fresh, with electrical conductivity (EC) measured between 80 and 1,250 µS/cm. Salinity shows an increase during periods of low streamflow and immediately following the first flush of salts and nutrients that occurs at the beginning of the wet season.

9.3.4.2.2 Tooloombah Creek

The tributary headwaters of Tooloombah Creek rise to the southwest of the Project area, where elevations of around 360 mAHD occur. The creek runs in a generally north easterly direction adjacent to the western Project boundary before joining Deep Creek around 2.3 km downstream of the Project. The mapped extent of Tooloombah Creek continues for another 1 km from the confluence, with a total catchment area of 370 km^2. There is limited streamflow data available for Tooloombah Creek; however, it is classified as a major, non-perennial creek (BoM 2011). It is a 5th order stream upstream of the Mamelon Creek confluence, becoming a 6th order stream until it's confluence with Deep Creek, and a 7th order stream until it's named end where it becomes the Styx River. Modelling of the creek flows indicate an annual average flow of 36 GL/a, and median of 12 GL/a (data from WRM Water and Environment, from rainfall runoff model presented in Flood Study and Site Water Balance Technical Report in Appendix A5b).

The main channel is significantly deeper than Deep Creek, with steep sided slopes that are fully vegetated and with minimal erosion evident. Upstream of the Project the channel is relatively narrow (4 to 5 m wide) but becomes wider downstream (10 to 15 m wide), with defined gentle meanders down toward the Deep Creek confluence. Outcropping sandstone occurs along the slopes and in some areas in the creek bed, which is also rocky (gravel and boulders) in some areas.

In an 'average year', Tooloombah Creek may have around three flow events, with an average water stage height of around 4 m. These flows are short-lived (generally a few days) and occur during high rainfall events. During extreme rainfall events, such as Cyclone Debbie during late-March 2017, Tooloombah Creek flood heights are observed to rise to around 1 m below the Bruce Highway bridge and, in low lying areas, water overflows the banks to cause local flooding. Tooloombah Creek reportedly has a less 'flashy' response to rainfall events than Deep Creek.

Large pools of water have been observed within the creek during all sampling events. Water held in these pools appears less turbid than Deep Creek pools, due to a combination of catchment hydrology (less erosion and slower flows), possible reduced stock access and increased residence time of pool water enabling sediments to settle. The presence of these pools is discussed further in Section 9.3.4.5.

9.3.4.2.3 Other Local Waterways and Drainage Features

Other local waterways and drainage features are summarised below.

Granite and Montrose Creeks

Granite and Montrose Creeks join into the Styx River, approximately 7 km downstream of the Deep and Tooloombah Creek confluence. These are both minor, non-perennial streams, with a combined catchment of 277 km^2, similar to the Deep Creek Catchment – Granite Creek drains 155 km^2 and Montrose Creek 122 km^2. Granite Creek is a 5^{th} order stream from where it exits the Broadsound Range to the west, while Montrose Creek is a 4^{th} order stream.

Monitoring data indicate the presence of pools within both streams, however both have recorded dry periods, indicating similar conditions to Deep Creek, based on the limited data, although the Montrose 2 (Mo2) site appears to have slightly more permanence than the Mo1 site, which has slightly more permanence than the Granite 1 (Gr1) site.

Barrack Creek

Barrack Creek joins into Deep Creek approximately mid-way through Deep Creek's passage past the mining lease, at the location of the proposed haul road crossing. This is likewise a minor, non-perennial stream, and is a sub-catchment of Deep Creek, being a 5^{th} order stream where it joins into Deep Creek. A site on Barrack Creek (Ba1) was adopted in 2011 – 2012, however flow was not observed in this time. Both the Ba1 and a new Ba1x site were monitored in 2017 – 2020, with water recorded as present on May – June 2017, and May 2020 – all other times were dry.

Mamelon Creek

Mamelon Creek is a 5^{th} order minor, non-perennial stream joining into Tooloombah Creek approximately 1.2 km upstream of the Bruce Highway. A site (Mam01) has been monitored since February 2020. Kyour Creek joins into Mamelon Creek approximately 4.7 km upstream from its confluence with Tooloombah Creek. Mamelon Creek forms part of the Tooloombah Creek catchment.

Neerim Creek

Neerim Creek is a 2nd order minor, non-perennial stream joining into Barrack Creek 9.1 km upstream of its confluence with Deep Creek, and is part of the Deep Creek catchment. A site (Nee1) has been monitored in this creek since February 2020.

Brussels Creek

Brussels Creek joins into Deep Creek approximately 7.6 km upstream of the haul road crossing (or 17.4 km upstream of the confluence with Tooloombah Creek). It is a minor, non-perennial stream, and part of the Deep Creek catchment.

Other Drainage Features

There are many drainage features across the local drainage network, including several within the mining lease:

- Minor un-named drainage lines feeding into Tooloombah Creek:
  - Three 1st order drainage lines, one of which (in the north) combines into a 2nd order drainage line before entering the creek just upstream of the Deep and Tooloombah Creek confluence; another drains from the proposed spillway location
  - One 2nd order drainage line, entering the creek in the north of ML 80187
- Minor un-named drainage lines feeding into Deep Creek:
  - Three 1st order drainage lines
  - One 2nd order drainage line, into which the proposed controlled discharge will flow
  - Two 3rd order drainage lines, one of which feeds from the Dam 4 and TLF location, and the other enters Deep Creek around 600m upstream of the haul road crossing.

9.3.4.2.4 Tidal Limit

The upstream tidal limit is defined as the point to which the high spring tide ordinarily flows (mean high water spring, [MHWS]), or the downstream limit of a watercourse under the Water Act (as identified in the *Coastal Protection and Management Act 1995*). This point is mapped at the downstream limit of the Styx River, 3.7 km downstream of the Project. Coastal waters are defined under the *Coastal Protection and Management Act 1995* as extending to the limit of the highest astronomical tide (HAT)[9], which maps the peak tidal limit as extending to the confluence of Deep and Tooloombah Creeks. As such, a tidal transition zone is mapped as between 2.3 to 3.7 km downstream from the Project.

Water samples collected periodically from two monitoring locations along Styx River (St1, located at the confluence of Deep and Tooloombah creeks and St2, located at the Ogmore Bridge) found salinity ranging from fresh (125 µS/cm) to saline (more than 35,000 µS/cm), depending on timing, tidal state and location of sampling. The fluctuation in tidal limit may be a function of channel morphology. The channel at the confluence of Deep and Tooloombah Creeks is approximately 10 to 12 m wide. Downstream, near Ogmore Bridge, the channel narrows to around 6 or 7 m before broadening as it opens into the Broad Sound estuary further downstream.

[9] HAT is the highest level which can be predicted to occur under average meteorological conditions and any combination of astronomical conditions. These heights will not be reached every year, but is not the upper level which can be reached, as storm surges may cause considerably higher levels to occur (DTMR 2019).

A major assemblage of Marine Couch (*Sporobolus virginicus*), as an indicator of the presence of saltmarsh vegetation, has been observed to just upstream of the Ogmore Bridge, with sparse occurrences up to the Deep and Tooloombah Creek confluence (CDM Smith 2018).

The sub-catchments of the Styx River catchment, i.e. below the confluence of Tooloombah and Deep Creeks, are dynamic estuarine environments where freshwater mixes with seawater providing brackish to saline conditions. Mapping, water quality results and the presence of Marine Couch indicate daily seawater intrusion to Ogmore Bridge with occasional peak tidal incursions closer to the confluence of Tooloombah and Deep creeks. This confirms the normal tidal limit based on MHWS at approximately 3.7 - 4.0 km downstream of the Project, which closely corresponds to the downstream limit of the Styx River under the Water Act, and the peak tidal limit to be at the confluence of Deep and Tooloombah Creeks, 2.3 km downstream from the Project (refer to Figure 9-9).

9.3.4.2.5 Water Types

With reference to the EPP (Water and Wetland Biodiversity) as shown in Figure 9-12, the receiving waterways for the project are all identified as Lowland freshwaters, with mid-estuary waters mapped downstream in the Styx River Estuary and lower estuary / enclosed coastal waters further seaward.

Two palustrine wetlands are mapped within the western side of the lease boundary, representing Wetlands 1 and 2.

Given the predominantly modified grazing nature of the catchment, a slightly-moderately disturbed ecosystem type is warranted, both for fresh and estuarine waters. This corresponds to the management intent mapped for freshwaters, under the ‘Styx River, Shoalwater Creek and Water Park Creek Basins Environmental Values and Water Quality Objectives’ (EHP 2014a). Estuarine waters (mapped as commencing 3.1 km below the Ogmore Bridge) are identified as moderately disturbed for a short 2 km section before entering waters identified as slightly disturbed (SD), both within the Styx River estuary and Broad Sound.

Lowland Freshwaters

Lowland freshwater streams are defined by the QWQG as freshwater streams below 150m or otherwise larger (third, fourth and fifth order or greater), slow-flowing and meandering streams and rivers. Their gradient is generally very slight, with substrates rarely cobble and gravel, and more often sand, silt or mud.

Estuarine Waters

The Styx River is tidally influenced for approximately 35 km in length to the Broad Sound estuary. It exhibits one of the largest tidal ranges in Queensland - it is known for its tidal bore, a wave or series of waves that propagate upstream in certain rivers subject to large tidal ranges.

The upstream boundary of an estuary is defined in Section B2.3.2 in the QWQGs as beginning at the upstream influence of MHWS - 3.7 - 4.0 km downstream of the Project (refer Section 9.3.4.2.3). No upper estuary can be defined for the Styx River Estuary using the decision tree from the QWQG (Figure B.1). Therefore, the middle estuary begins below the normal tidal limit and extends downstream to where it meets the lower estuary.

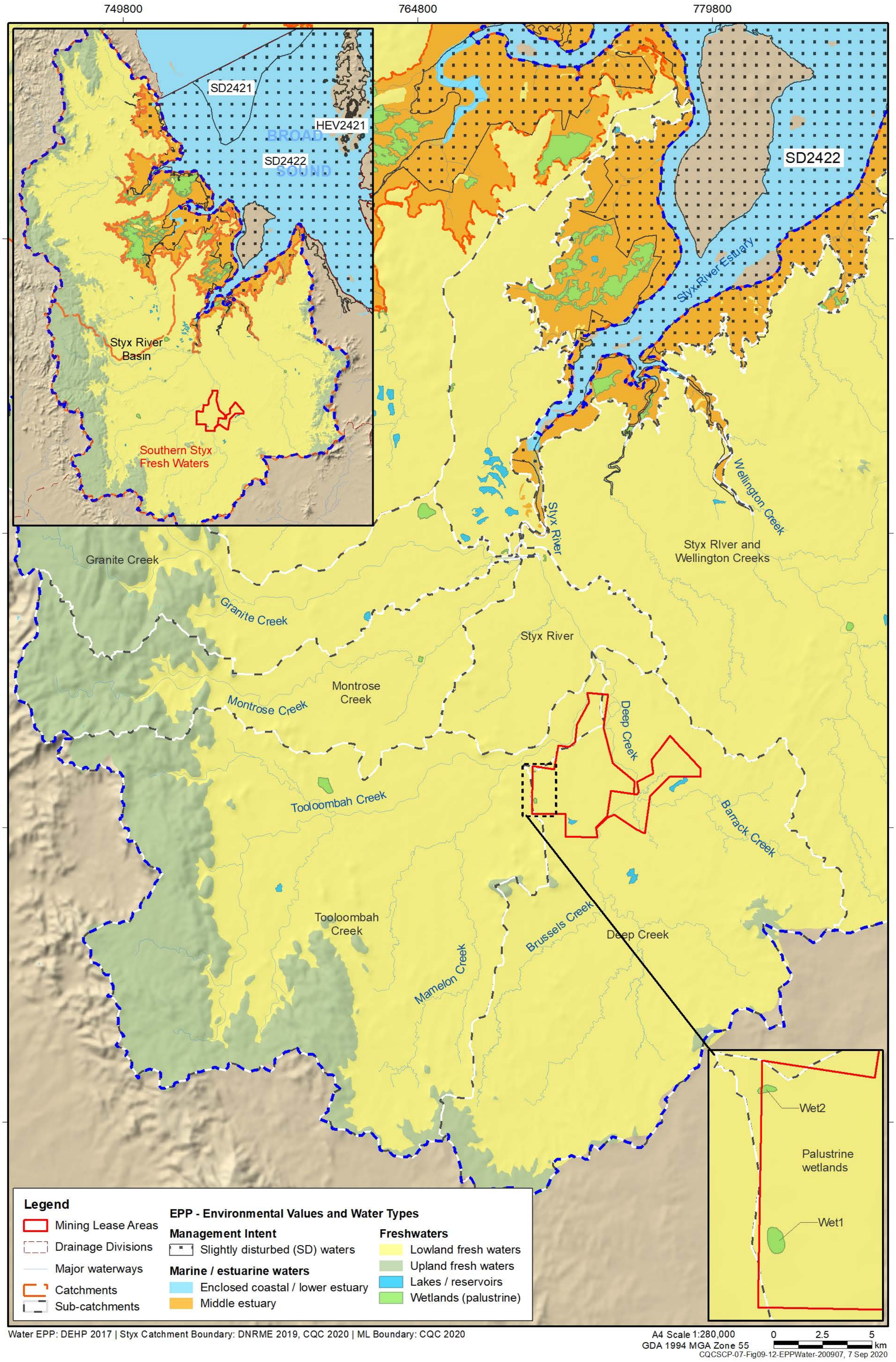

Figure 9-12: EPP (Water and Wetland Biodiversity) water types and management intent

This is mapped by EHP (2014a) as a short 1 km section before entering the enclosed coastal waters of Broad Sound, although the further 24 km section to the coast is mapped elsewhere as the Styx River estuary. From this it may be concluded that the St1 site would be freshwater, with the St2 site mid-estuary.

9.3.4.3 Geomorphology

The alluvium in the Styx River valley was formed within the Quaternary Period (2.58 million years ago to the present) of the Cainozoic Era (66 million years to the present). Two main periods of Quaternary alluvial deposition occurred in coastal streams within alluvial valleys - the first was responsible for formation of the Qpa terraces that bound the rivers of the region, while the second was responsible for formation of the Qa benches and inset floodplains that are found within the macro-channel formed in Qpa sediments (refer to the fluvial geomorphology report in Appendix A5d).

The current watercourses are characterised by active channels deeply incised into a broad plain of older alluvium (Qpa). The active channel comprises depositional benches and inset floodplains formed through the Holocene (Qa) from a mix of material sourced from the catchments in recent times plus reworked older Pleistocene material. The main channels are thus considered partly confined by the older alluvium unit.

A detailed fluvial geomorphology assessment was prepared by Fluvial Systems, presented in Appendix A5d. This found most of the stream reaches were in a stable, moderate geomorphic condition. One migrating bend on the Styx River was identified as a significant source of sediment to the river. No knickpoints or zones of major geomorphic instability were observed on the mapped watercourses. However, the area contains a significant number of alluvial gullies and small tributaries incised into old alluvium. These are potentially sources of high sediment loads to the river system, and thus the GBR.

9.3.4.4 Flood Hydrology

A hydrologic assessment was undertaken to produce flood hydrographs for input to hydraulic model simulations that predict flood characteristics such as inundation depth, flood extent, and flow velocities. Design discharges for the Styx to Ogmore Bridge for the 10%, 5%, 2%, 1%, 0.1% and PMF events is shown in Table 9-3.

Table 9-3: Existing design discharge volumes, Styx River to Ogmore Bridge

Design event	Adopted design peak discharge (m^3/s)	Critical storm duration (hours)
10% AEP	1,200	36
5% AEP	1,790	24
2% AEP	2,800	24
1% AEP	3,770	24
0.1% AEP	5,670	36
PMF	17,325	12

These flood hydrographs were used as input boundary conditions to the TUFLOW hydraulic model used to simulate flood behaviour in the study area. The modelling found that, with both Tooloombah and Deep creeks characterised by deep channels, the majority of flow was confined within the bank. In the 1% AEP event there is a minor flow breakout from Deep Creek upstream of the Bruce Highway that contributes flow to the local drainage paths through the proposed mine area. Flood depths within the creek channel for all events exceed 4.5 m.

Velocities within the creek are generally between 1.5 m/s and 2.5 m/s across the range of events for existing conditions.

Modelled flood depths for the existing 1% AEP, 0.1% AEP and PMF events within the mining lease area are shown in Figure 9-13 to Figure 9-15. The results for the full range of flood events can be found in Appendix A5b.

9.3.4.5 Groundwater – Surface Water Interactions

Due to the ephemeral nature of the surface water systems in the Project area, the interplay between storm events, bank storage and groundwater is complex. For both creeks, a lateral wet season / flood recharge process occurs, whereby water rising in the creeks recharges bank storage, which will affect surrounding alluvial aquifers and cause a rise in the water table close the creeks. Once the storm event has passed, water levels in the creeks subside, and return flow from bank storage to the creek occurs, resulting in a period of post-storm baseflow.

Most reaches of both creeks are identified as having a groundwater table below the base of the creek in the dry season, and are therefore without groundwater inflows other than return bank storage flows. However, two of the Tooloombah Creek pools appear to have an external saline water source sustaining them through the dry season. The Surface Water/Groundwater Interactions Report in Appendix A6d concluded that the creeks are primarily bank flow fed, rather than from elevated water table aquifers, with the source of this saline water being either salts flushed out of bank storage, or more saline water recharging the alluvial aquifer from seasonally elevated water tables (i.e. from the underlying Styx Coal Measures during the wet season) that remains behind when regional water tables decline.

Deep Creek is responsive to rainfall and is highly turbid. During the dry season, the riverbed is mostly dry except for a series of disconnected pools (mostly temporary). A fault line exists along the channel of Deep Creek adjacent to the Project, with these reaches likely to lose more water to lateral flow moving east away from the creek than areas to the north and south, rather than being stored for subsequent return to the creek – i.e. soil moisture and surface water pools within these sections are unlikely to be sustained during the dry season.

Tooloombah Creek is also responsive to rainfall; however, it is much less turbid than Deep Creek, possibly due to the different substrate material and the deeper channel limiting cattle access. Low-lying areas of the Tooloombah Creek catchment are subject to flooding and large pools of water occur along the creek during dry periods. Tooloombah Creek likely receives higher amounts of groundwater inflow compared with Deep Creek, and groundwater inputs are likely to maintain water in some of the pools. ELA conducted an assessment of the pools within Deep and Tooloombah Creek, identifying their persistence as part of the technical report in Appendix A10a. The identified pools and their level of persistence are shown in 9-13 and Figure 9-16.

Overall, the assessment identifies a higher bank storage and return flux in Tooloombah Creek compared to Deep Creek. Pools along Tooloombah Creek appear to be permanent or semi-permanent, while those in Deep Creek are generally ephemeral, although it is anticipated that some permanent pools exist in the downstream reach of Deep Creek nearer to the confluence with Tooloombah Creek.

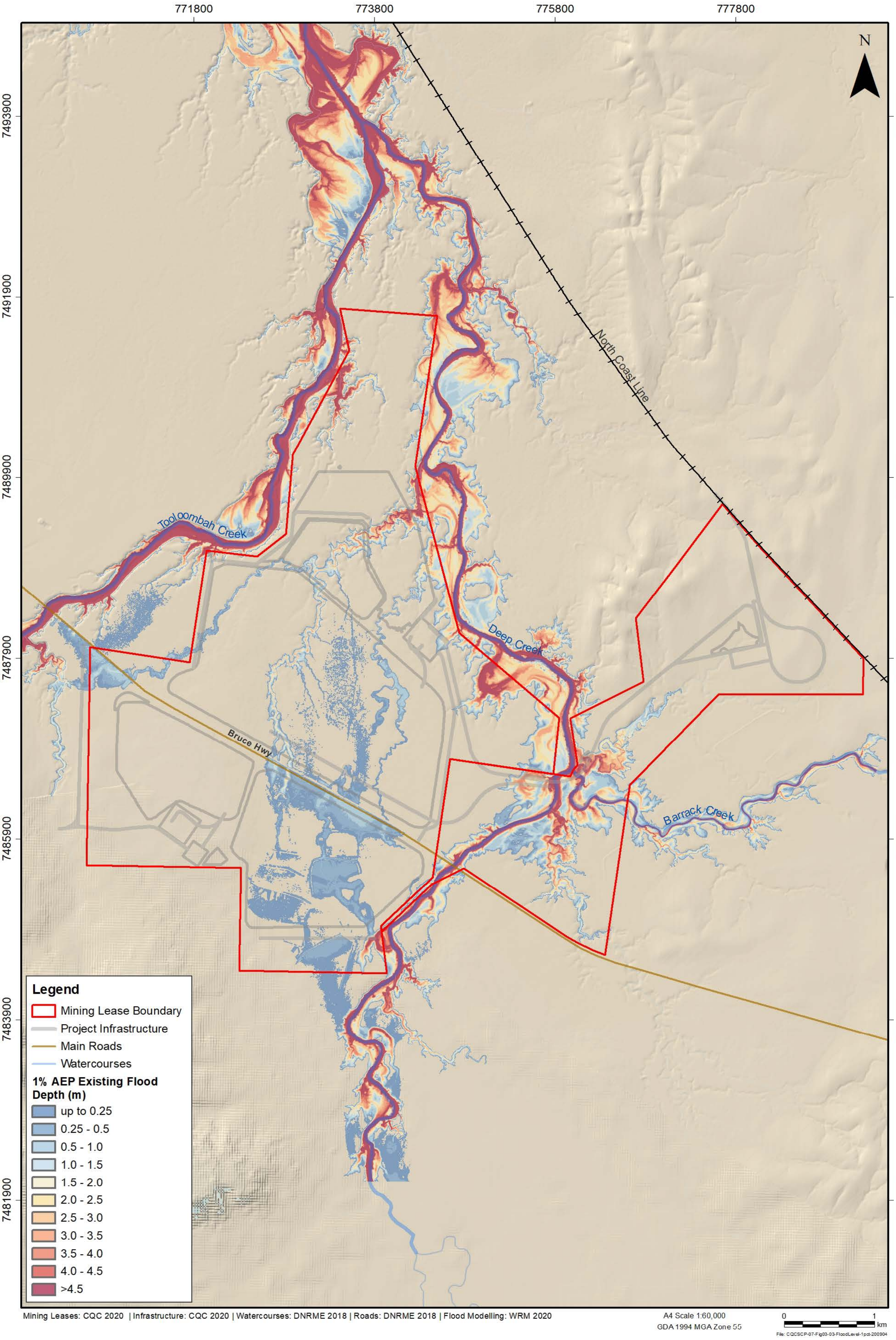

Figure 9-13: Existing 1% AEP flood depths

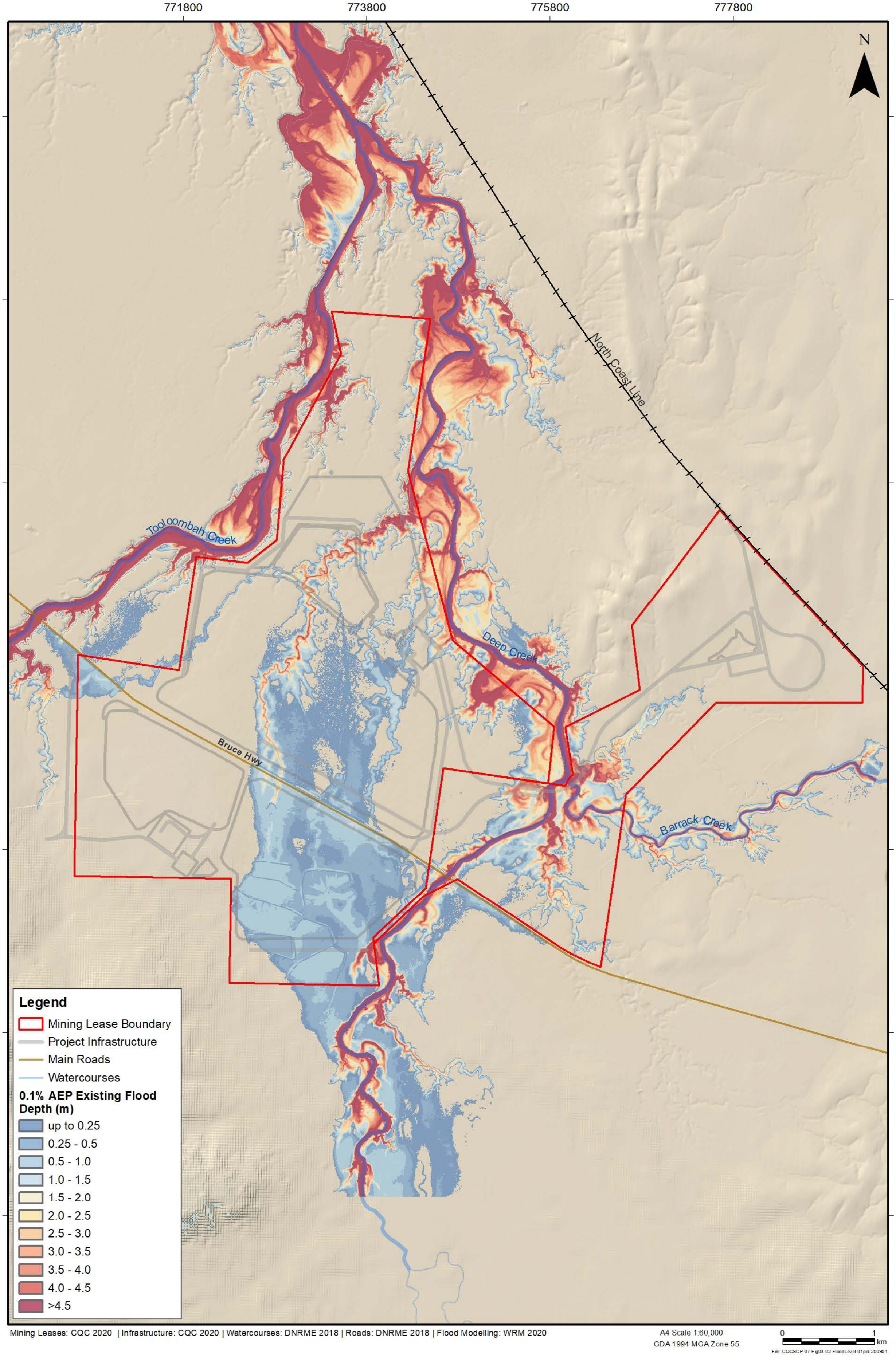

Figure 9-14: Existing 0.1% AEP flood depths

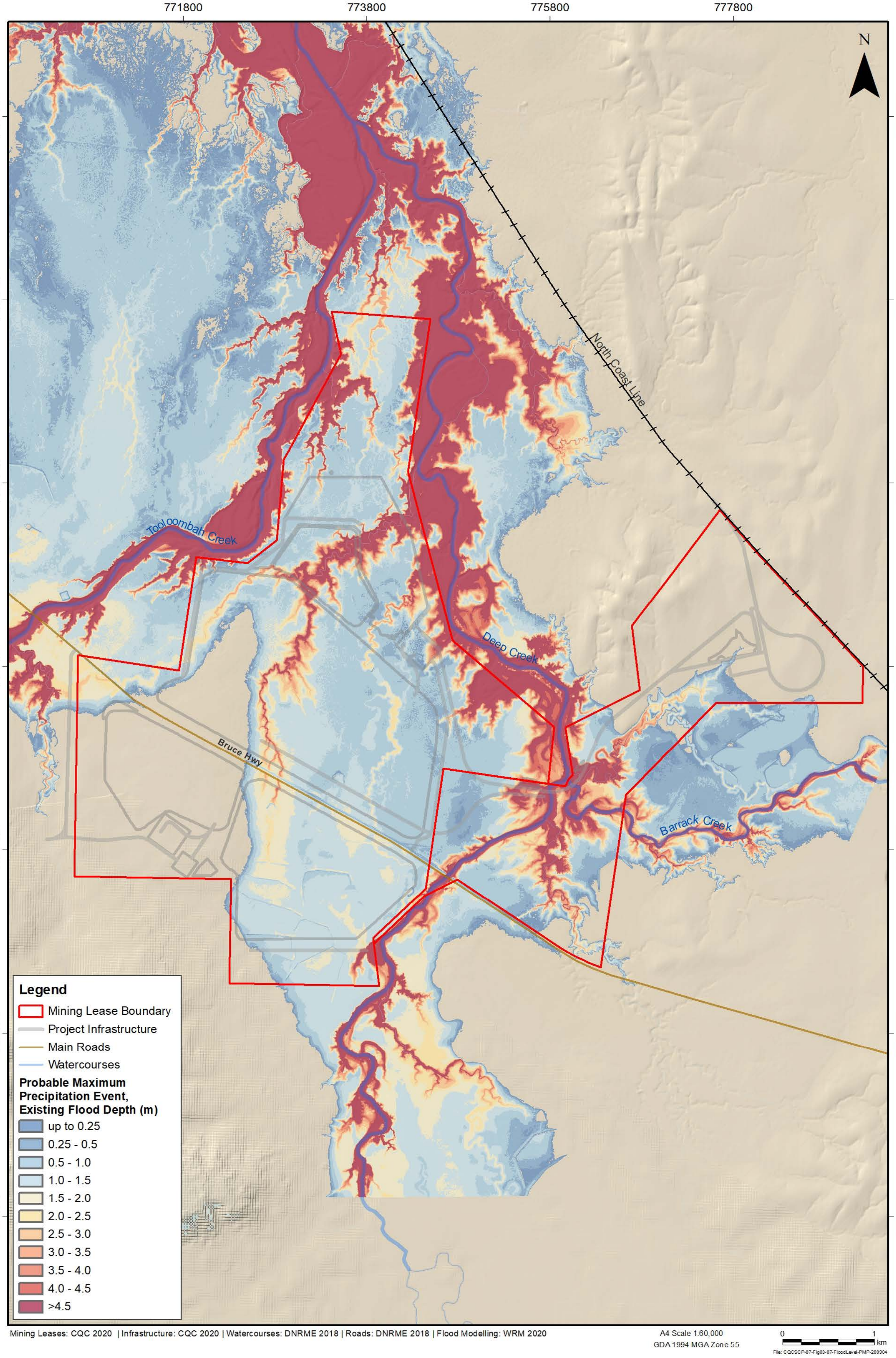

Figure 9-15: Existing PMF flood depths

Table 9-4: Summary of pools adjacent to Project Area and their potential groundwater dependence

Pool ID	Location	Comments
Key pools subject to water quality or flow monitoring		
To1	Tooloombah Creek	Semi-Permanent (dry on 2 of 50 inspections)
To2	Tooloombah Creek	Permanent (dry on 0 of 41 inspections)
To3	Tooloombah Creek	Semi-Permanent (dry on 1 of 32 inspections)
ToGS1	Tooloombah Creek Gauging Station	Permanent
DE1	Deep Creek	Ephemeral (dry on 18 of 46 inspections)
DE2	Deep Creek	Ephemeral (dry on 9 of 48 inspections)
DE3	Deep Creek	Ephemeral (dry on 13 of 45 inspections)
DE4	Deep Creek	Ephemeral (dry on 4 of 36 inspections)
DE5	Deep Creek	Semi-Permanent (dry on 2 of 32 inspections)
Other pools that have been mapped		
Pool 4	Tooloombah Creek	Ephemeral (water in 2011, dry in April and September 2018)
Pool 5	Tooloombah Creek	Appears permanent (water in 2011, throughout 2018)
Pool 6	Tooloombah Creek	Appears permanent (water in 2011, April and September 2018)
Pool 7	Deep Creek	Small pool 5 m wide, 1 m deep. Water in May 2020. Otherwise satellite imagery inconclusive.
Pool 19A and 19B	Barrack Creek	Pair of pools 4 m wide, 1-1.5 m deep. Water in May 2020. Otherwise satellite imagery inconclusive.
Pool 10	Tooloombah Creek	Large pool 10 m wide, 2-3 m deep. Appears permanent (water in 2011, April and September 2018, May 2020).
Pool 11	Tooloombah Creek	Appears permanent (water in 2011, April and September 2018, May 2020).
Pool 12	Tooloombah Creek	Appears permanent (water in 2011, April and September 2018, May 2020).
Pool 13	Styx River	Permanent, tidally affected.
Pool 14	Deep Creek	Small pool below DE5. Appears ephemeral (water in May 2020, July 2018, but appears to be dry in satellite imagery – 2011, April and September 2018.
Pool 20	Deep Creek	Small pool below DE4, 4 m wide. Dam or wetland that appears to dry out between April and September 2018 in satellite imagery.
Pool 21	Deep Creek	Small pool adjacent to Deep Creek. Appears ephemeral (water in May 2020, but appears to be dry in satellite imagery – 2011, April and September 2018.
Pool 22	Deep Creek	Satellite imagery inconclusive. Likely ephemeral.
Pool 23	Deep Creek	Satellite imagery inconclusive. Likely ephemeral.
Pool 24	Deep Creek	Satellite imagery inconclusive. Likely ephemeral.
Pool 25	Deep Creek	Satellite imagery inconclusive. Likely ephemeral.
Pool 26	Deep Creek	Small pool. Satellite imagery inconclusive. Likely ephemeral.
Pool 27 - 29	Deep Creek	String of ephemeral pools. Ephemeral.
Pool 30	Deep Creek	Medium sized pool. Satellite imagery inconclusive. Likely ephemeral.

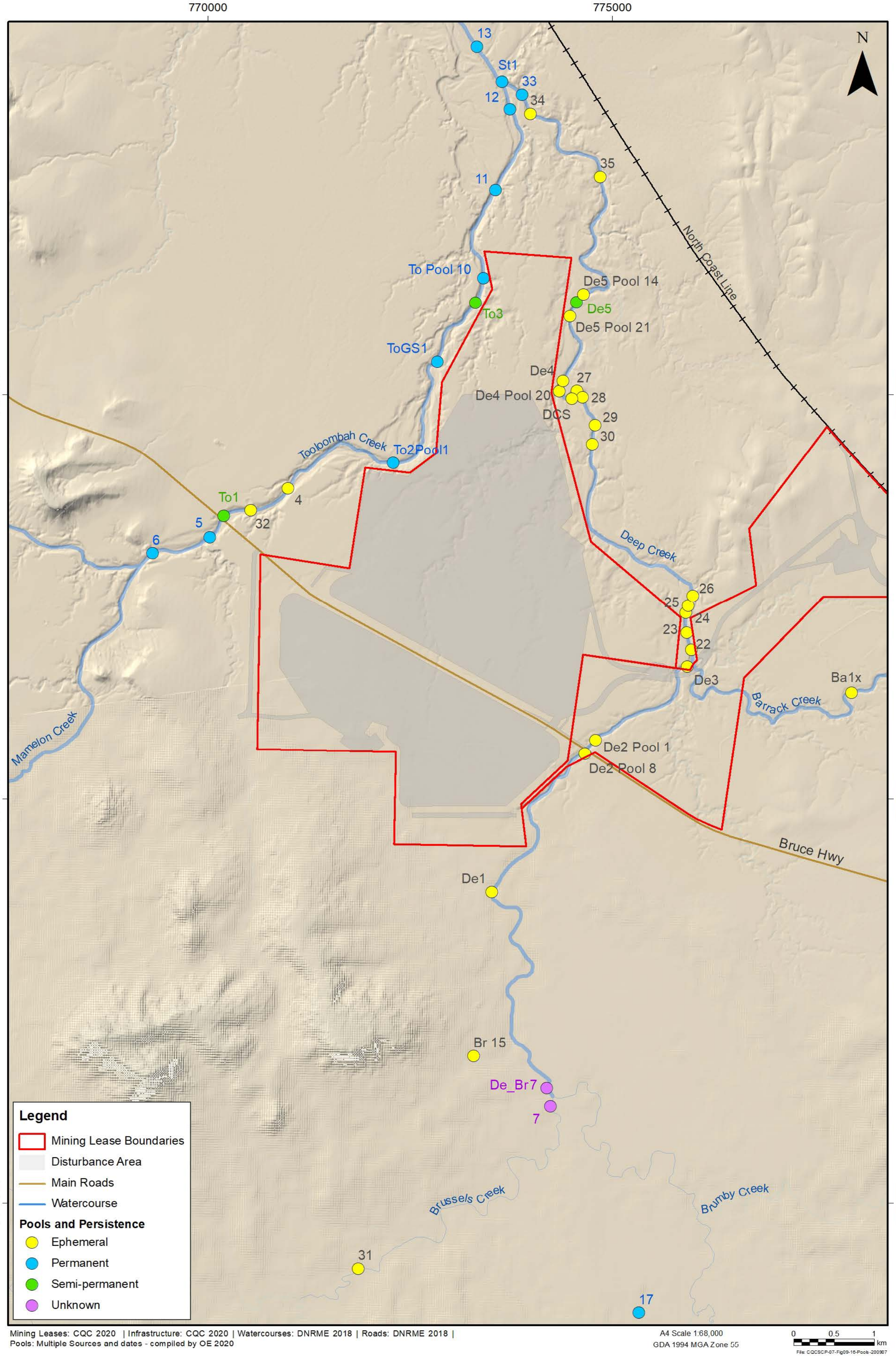

Figure 9-16: Location of identified pools and their persistence

The data shows an apparent trend of increasing permanence with distance downstream.

The conceptual processes above can be described in terms of gaining and losing stream reaches, and mixes of the two, as follows:

- Predominantly gaining, permanently connected stream reaches - reaches which are permanently connected to groundwater, by being below the steady state water table, predominantly gaining water.
- Losing/Gaining, semi-permanently and non-permanently connected stream reach - gaining if intersecting the groundwater table, and losing if not.
- Losing, disconnected stream reaches - permanently above the groundwater table and predominantly losing water.

These systems are shown in Figure 9-17 for storm event or wet season conditions (top row), post event conditions (middle row), and dry season conditions (bottom row), for the above three dot points (shown left to right respectively). Based on the evidence provided above, and detailed further in Chapter 10 – Groundwater, the systems in the Project area predominantly display the middle (losing / gaining, semi-permanently and non-permanently connected stream reaches) and right hand side (losing, disconnected stream reaches) of Figure 9-17.

9.3.5 Environmental Values

EVs for water are the qualities of water that support a level of aquatic ecosystem function and / or human water uses. These EVs can be impacted by the effects of habitat alteration, waste releases, contaminated runoff and changed flows to ensure healthy aquatic ecosystems and waterways that are safe for community use.

Specific EVs were developed for the Styx River, Shoalwater Creek and Water Park Creek Basins in 2014 under the Environmental Protection (Water) Policy 2009 (EPP Water) in the document 'Styx River, Shoalwater Creek and Water Park Creek Basins Environmental Values and Water Quality Objectives' (EHP 2014a). The EVs for the waters relevant to the Project are shown in Table 9-5.

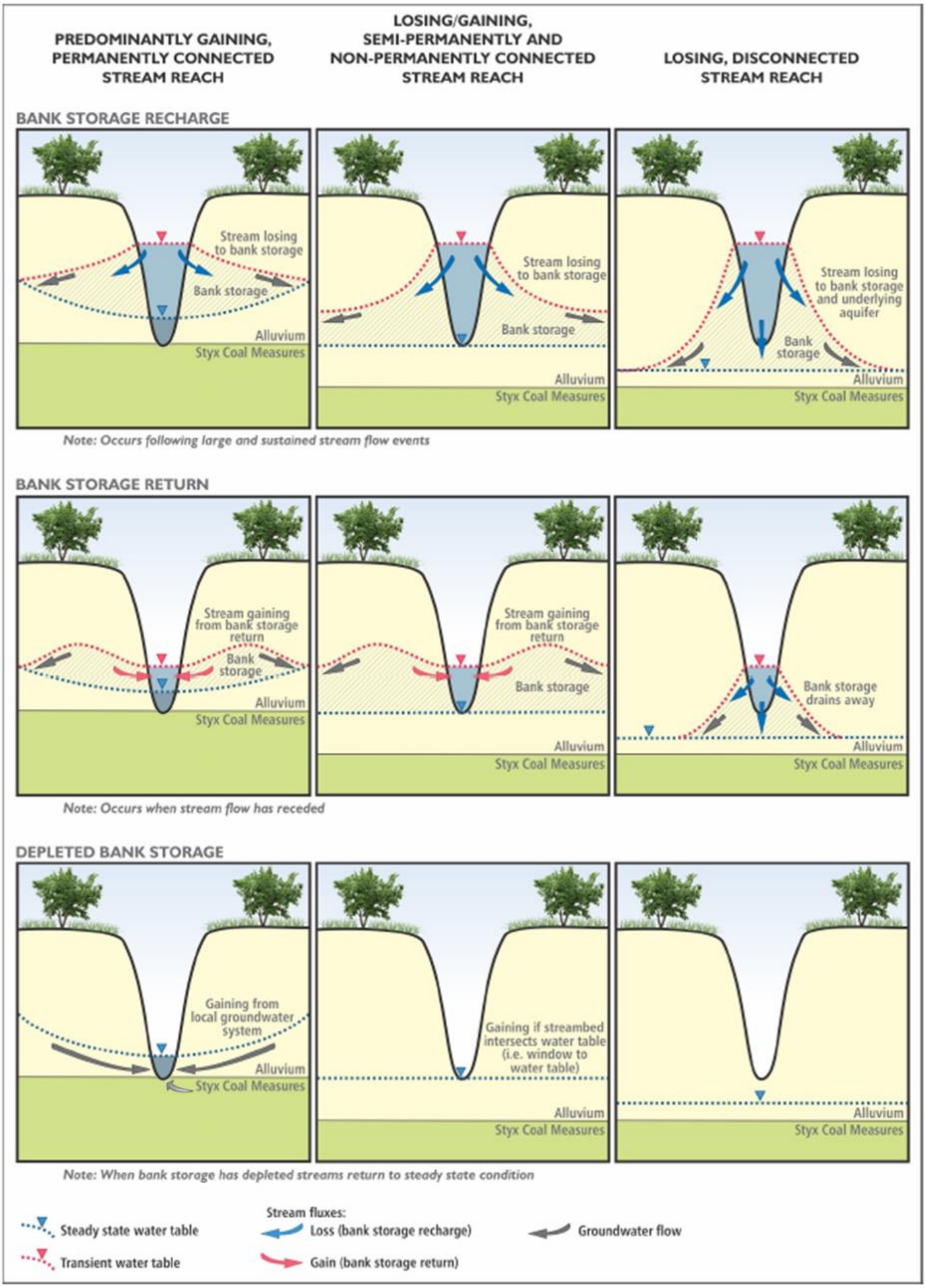

Figure 9-17: Mechanisms of surface water – groundwater interactions

Table 9-5: Environmental values for Project catchments

Symbol	Environmental Value	Surface Fresh Waters (rivers, creeks, streams) in developed areas (e.g. urban, industrial, rural residential, agriculture, farmlands) - Southern Styx fresh waters (including Granite, Tooloombah and Wellington creeks)	Estuaries / Bays, Coastal and Marine Waters - Styx River, St Lawrence, Waverley and other creeks (estuarine reaches)
	Aquatic ecosystems (SMD)	✓	✓
	Irrigation	✓	
	Farm supply	✓	✓[1]
	Stock water	✓	✓[1]
	Aquaculture		
	Human consumer	✓	✓
	Primary recreation	✓	
	Secondary recreation	✓	✓
	Visual recreation	✓	✓
	Drinking water	✓	
	Industrial use		
	Cultural and spiritual values	✓	✓

Table notes:

1 It is considered unlikely that the true estuarine waters of the Styx River would be suitable for farm supply or stock water, although suitably fresh flows do occur in the upper reaches during flow periods

9.3.6 Existing Water Quality

9.3.6.1 Comparison with Guideline Values

WQOs are described for the Project catchments in the document 'Styx River, Shoalwater Creek and Water Park Creek Basins Environmental Values and Water Quality Objectives' (EHP 2014a) for several EVs, notably protection of aquatic ecosystems, with linkage to other sources for relevant guideline values. The technical work presented in the Surface Water Quality Technical Report in Appendix A5a provides median and 80th percentiles (95th percentiles for toxicants) for different flow regimes. Given the low occurrence of flow within the waterways, the bulk of the samples occur in either baseflow or no-flow conditions (the latter where water pools intermittently or permanently), and as such and given the available data, the key statistics have been based on the baseflow / no-flow regimes combined.

Importantly, the results are compared to the EPP (Water and Wetland Biodiversity) guideline values, which are baseflow only criteria. As such, some exceedances may be expected.

The statistics for Deep and Tooloombah Creeks, the Deep and Tooloombah Creek confluence and the Styx River at the Ogmore Bridge are summarised in Table 9-6, against the guideline values for the relevant EVs from Section 9.3.5.

The data shows exceedances of the Aquatic Ecosystem guideline values for:

- the dissolved oxygen guideline value at all sites
- suspended solids and turbidity at Deep Creek, and a marginal suspended solids result at the St1 confluence site
- ammonia and total nitrogen at all sites and
- total phosphorous in Deep Creek, and at the St2 Styx River site.

For metals and metalloids, aluminium, copper and zinc are consistently high and above the guideline value at all sites, with exceedances also found for arsenic (marginal at the St2 Styx River site), lead (Deep Creek), uranium (St1 and St2 sites) and possibly selenium in the Styx River, although the marine arsenic and selenium and both fresh and marine uranium guideline values are low reliability. Iron is above the low reliability guideline value at all sites other than St1.

A number of other sites recorded medians less than the LOR, but which was above the guideline value, and so whether the parameter is actually above the guideline value cannot be determined with certainty.

For the Stock Watering EV, guideline values are exceeded for TDS at the St2 Styx River site, and for chloride at both the St1 and St2 sites. The statistics for selenium resulted in a range at the St2 Styx River site which indicates exceedance for this parameter as well. For irrigation, compared to the long term irrigation guideline values, total phosphorous is high at Deep Creek and the St2 Styx River site, and selenium is again elevated at the St2 Styx River site (as above for stock watering).

Table 9-6: Surface water quality results summary

Parameter	Guideline Values*					Results – Medians[2]			
	Aquatic Ecosystem Protection (SMD)[4]		Stock watering	Irrigation	Water supply[1]	Freshwater			Estuarine
	Freshwater	Marine				Deep Creek	Tooloombah Creek	Confluence (St1)	Styx River (St2)
Phys-chem									
pH (pH units)	6.5 - 8.0	7.0 - 8.4	-	-	6.5 - 8.5[A]	7.7	7.9	7.7	7.8
DO (% Sat)	85 - 110	85 - 100	-	-	>85[A]	**56.3**	**76.6**	**78**	**81**
EC (µS/cm)	-	-	-	Refer Appendix A5a		348 (very low)	829 (low)	4,180 (high)	24,400 (extreme)
TDS (mg/L)	-	-	4,000	-	600[A]	522	548.7	2460 W	17100 StW
Chloride (mg/L)	-	-		Refer Appendix A5a		63	210	1220 St	8280 St
Sulfate (mg/L)	-	-	1,000	-	250[A]	8.9	9.7	126	974
Suspended Solids	10	-	-	-	-	**29.7**	7.7	**10**	16
Turbidity (NTU)	50	-	-	-	-	**165.5**	10	11	15
Nutrients (mg/L) – as N for nitrogen compounds, and as P for phosphorous compounds									
Ammonia	0.02	0.01	-	-	0.5[A]	**0.042**	**0.028**	**0.04**	**0.07**
Nitrate	-	-	400	-	50[H]	<0.012	<0.01	<0.01	<0.01
Oxidised nitrogen	0.06	0.01	-	-	-	<0.012	<0.01	<0.01	<0.01
Total nitrogen	0.5	0.3	-	5	-	**0.94**	**0.417**	**0.4**	**0.5**
Total phosphorous	0.05	0.025	-	0.05	-	**0.117** Ir	0.027	0.02	**0.06** Ir
Filterable reactive phosphorous	0.02	0.01	-	-	-	<0.01	<0.01	<0.01	<0.01
Metals and Metalloids (mg/L)									
Aluminium	0.055	0.0005[LR]	5	5	0.2[A]	**3.73** W	**0.71** W	0.02 - **0.1**	**1.75** W
Antimony	0.009[LR]	0.27[LR]	-	-	0.003[A]	<0.03	<0.01	<0.01	<0.01
Barium	-	-	-	-	2[H]	0.088	0.131	0.369	0.229

Parameter	Guideline Values*					Results – Medians[2]			
	Aquatic Ecosystem Protection (SMD)[4]		Stock watering	Irrigation	Water supply[1]	Freshwater			Estuarine
	Freshwater	Marine				Deep Creek	Tooloombah Creek	Confluence (St1)	Styx River (St2)
Beryllium	0.00013[LR]	0.00013[FLR]	-	0.1	0.06[H]	<0.03	<0.01	<0.01	<0.01
Boron	0.37	5.1[LR]	5	0.5	4[H]	<0.1	<0.1	0.16	0.65
Cadmium	0.0002	0.0007	0.01	0.01	0.002[H]	<0.0001	<0.0001	<0.0005	<0.0005
Chromium	0.001	0.0044	1	0.1	0.05[H,3]	**0.0028**	<0.001	<0.005	≤0.005
Cobalt	0.0014[LR]	0.001	1	0.05	-	<0.009	<0.001	<0.01	<0.01
Copper	0.0014	0.0013	1	0.2	2[H]/ 1[A]	**0.007**	**0.002**	**0.002**	**0.003**
Iron	0.3[LR]	0.3[FLR]	-	0.2	0.3[A]	**2.27** W	**0.51** W	≤0.06	**1.18** W
Lead	0.0034	0.0044	0.1	2	0.01[H]	**0.0042**	<0.007	<0.01	<0.01
Manganese	1.9	0.08[LR]	-	0.2	0.5[H] / 0.1[A]	0.651 W	0.276 W	0.481 W	**0.496** W
Mercury	0.00006	0.0001	0.002	0.002	0.001[H]	<0.0001	<0.0001	<0.0001	<0.0001
Molybdenum	0.034[LR]	0.023[LR]	0.15	0.01	0.05[H]	<0.006	<0.007	0.005	0.012
Nickel	0.011	0.007	1	0.2	0.02[H]	0.004	0.005	0.002	0.003
Selenium	0.005	0.003[LR]	0.02	0.02	-	<0.01	<0.01	<0.03	0.02 - **0.05** StIr
Silver	0.00005	0.0014	-	-	-	<0.001	<0.001	<0.001	<0.005
Strontium	-	-	-	-	-	0.5	0.6	1.4	1.7
Thallium	0.00003[LR]	0.017[LR]	-	-	-	<0.03	<0.01	<0.01	<0.01
Tin	0.003[LR]	0.01[LR]	-	-	-	<0.037	<0.01	<0.01	<0.01
Titanium	-	-	-	-	-	0.12	0.07	0.16	0.19
Uranium	0.00005[LR]	0.00005[FLR]	0.2	0.01	-	<0.001	<0.001	**0.001**	**0.002**
Vanadium	0.006[LR]	0.1		0.1	-	0.005	<0.01	<0.04	<0.05
Zinc	0.008	0.015	20	2	-	**0.018**	**0.018**	**0.012**	**0.015 - 0.025**

Table notes:

* From EHP (2014a). Note that in most cases, particularly for agricultural values (irrigation and stock watering), there are caveats to the GVs provided, and the source must be consulted in the use of the values provided

1 Table 4, EHP (2014a). Metals and metalloids criteria from NHMRC (2018) - A = aesthetic criteria; H = health criteria

2 Exceedances are denoted as either red text for aquatic ecosystem exceedance, or a coloured letter for other guideline values: Stock (St), Irrigation (Ir), Water Supply (W). Orange indicates the result is <LOR, but greater than the aquatic ecosystem guideline value

3 As Cr(VI)

4 LR = low reliability guideline value; FLR = freshwater low reliability guideline value, where used for marine guidelines

Compared to the water supply / drinking water EV, a number of parameters exceed the guideline values, including TDS (St1 and St2 sites), aluminium (all sites other than St1), arsenic (marginal at the St2 Styx River site), iron (all sites other than St1) and manganese (all sites). Arsenic and manganese exceedances were both related to health levels.

The results indicate that the existing aquatic ecosystem guideline values will be routinely exceeded under natural conditions for dissolved oxygen at all sites; suspended solids and turbidity at Deep Creek, and at times at the St1 confluence site; for ammonia and total nitrogen at all sites; and for total phosphorous in Deep Creek and at the St2 Styx River site.

Water in Deep and Tooloombah Creeks appears suitable for stock watering and irrigation (although a salt / sodicity / chloride assessment is required on a use-specific basis). There are some exceedances of the aesthetic criteria related to drinking water, which could be managed, although arsenic and manganese levels are at or above the relevant health criteria.

9.3.6.2 Water Quality Characteristics

9.3.6.2.1 Salinity, Chloride and Sulfate

The five Deep Creek sites have generally similar levels of salinity, but a clear increasing trend is seen between the upstream and downstream sites in Tooloombah Creek, with the highest at the St2 Styx River site. Chloride levels follow a similar trend with the To2 and downstream sites recording higher salinity and chloride levels than Deep Creek.

Salinity can be seen to respond to rainfall in the creeks, with the effect more pronounced in Tooloombah Creek, which shows higher levels of salinity, particularly in the To2 and To3 sites. Deep Creek shows some of the same pattern though the levels are generally too low to see much of a difference. The effect of upstream runoff can be seen in both the St1 and St2 sites, which remain relatively unperturbed for smaller events, but drop sharply for larger sustained events.

Sulfate levels are relatively similar between the Deep and Tooloombah Creek sites, with no increase in levels in Tooloombah Creek until the St1 and St2 sites, with an increase from St1 to St2 similar to that for salinity - this combined with chloride levels and boron is indicative of the effect of seawater, with sulfate being one of the most abundant ions in seawater, and both St1 and St2 known to be tidally affected (St2 more so than St1).

Figure 9-18 shows the change in concentration (as 95th percentiles) of chloride, sulfate and boron moving downstream in Deep and Tooloombah Creeks, and including the confluence, which is affected by peak tides, and the Ogmore Bridge, which is within the normal tidal limit. As can be seen, while chloride levels increase in Tooloombah Creek upstream of the confluence, sulfate and boron levels do not, and are identical to those found in Deep Creek. Given this, it can be seen that catchment mineralogy (including groundwater where relevant) is the source of elevated salinity in Tooloombah Creek upstream of the confluence, rather than seawater.

The Deep Creek sites show little change in sulfate over time, although high levels were identified in 2011/2012 which have not been seen since. Tooloombah Creek shows some variable sulfate levels, with some of the peaks corresponding to higher salinity levels, but not clearly increasing due to rainfall induced flow or no-flow periods. The St1 and St2 sites show clear increases in sulfate in dry periods, more so at the more tidal St2 site, mirroring the salinity pattern seen at these sites. Other nearby creek systems are similar to Deep Creek, being quite low in salinity and sulfate levels.

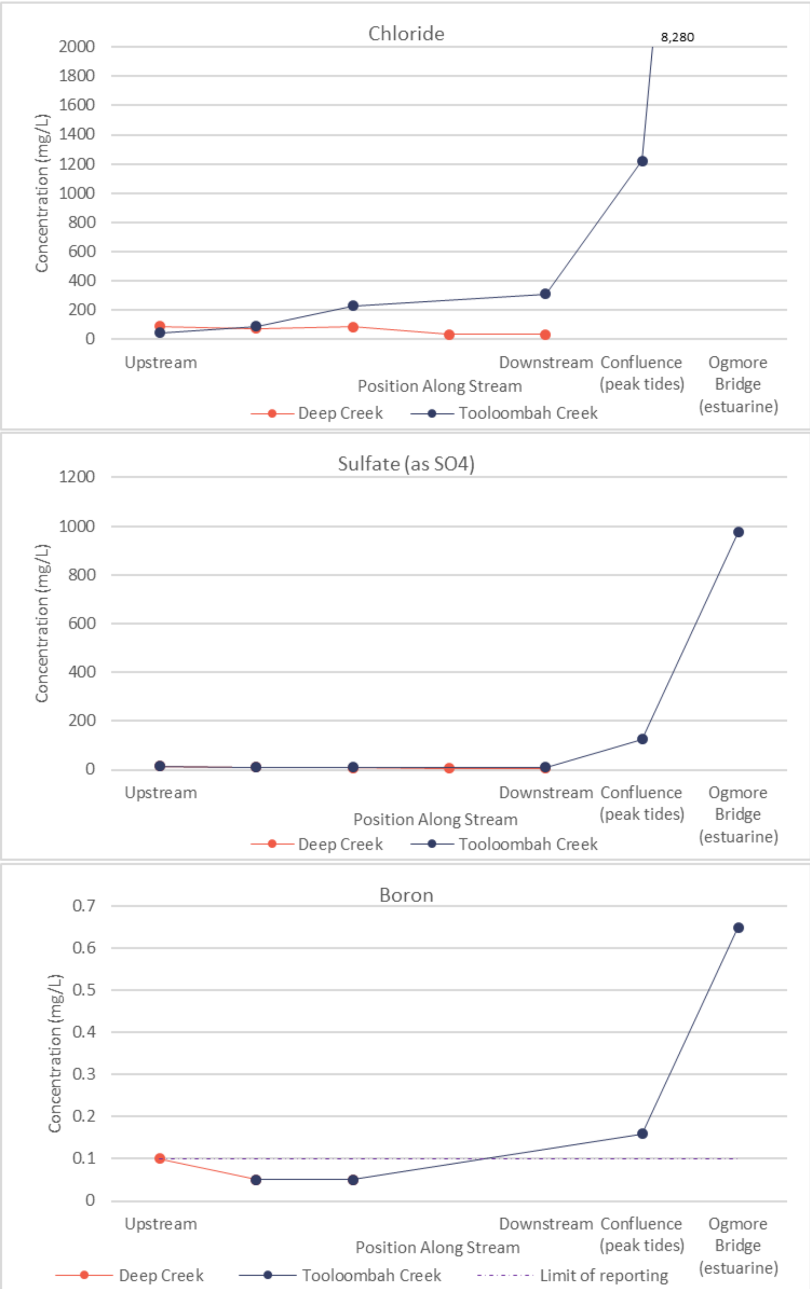

Figure 9-18: 95th percentile concentrations of chloride, sulfate and boron along creeks

Refer to Figure 9-19 and Figure 9-20 for EC and sulfate boxplot summaries, and Figure 9-23 to Figure 9-25 for EC over time in the following pages.

9.3.6.2.2 Dissolved Oxygen

Dissolved oxygen levels are often lower than the DGVs in both creeks, and generally lowest in the Deep Creek sites. Over time, a pattern of highly variable low dissolved oxygen levels is seen in dry periods in Deep Creek, with a drop immediately after rainfall events, and then rises during and immediately after flow periods cease. A decline is then seen as flows stop and pools stagnate. Tooloombah Creek shows a similar drop in first flush flows, but levels appear to rise in some dry periods, and fall in others, possibly depending on algal growth (as Deep Creek sites are much more turbid). At the St1 and St2 sites, dissolved oxygen levels are more stable, though rises are seen during dry periods, and drops for the first flush flows, as for Tooloombah Creek.

These results reflect the ephemeral nature of the creek systems, with dissolved oxygen dropping with first flush flows, fluctuating but generally higher during flow periods, and then as flows slow and cease dropping again as pool systems stagnate, particularly so in the less permanent and lower flow systems of Deep Creek and the dams. In some situations, it appears that primary productivity, particularly in larger systems in Tooloombah Creek with clearer water, may cause it to rise.

All other creeks are similar to Tooloombah Creek, with the exception of Amity Creek (similar to Deep Creek), with high levels observed in Wetland 1, likely due to high primary productivity.

A boxplot summary is shown in Figure 9-21, and further data included in the Surface Water Quality Technical Report in Appendix A5a.

9.3.6.2.3 pH

pH levels are above neutral, at 7.7 – 7.9 for the creeks, around 7.5 pH units for the dams and approximately neutral for the wetlands (6.9 – 7.3). All medians are within the DGV range other than To2 and Neerim Creek (marginally above) and To4 (above), and most 80th percentiles are above the upper DGV range, with the exception of De4.

Over time, fluctuations are seen in pH, appearing to rise slightly during dry periods, and falling in wet periods, although these patterns are not entirely clear at all times.

A boxplot summary is shown in Figure 9-22, and further data included in Appendix A5a.

9.3.6.2.4 Suspended Solids and Turbidity

Total suspended solids appear to increase moving downstream in Deep Creek, which is also seen but to a lesser extent in Tooloombah Creek, which in general has lower suspended solids levels. Site To4 appears more like the Deep Creek sites than Tooloombah Creek sites, with the St2 site also similar to Deep Creek. Other creeks are variable, with Amity Creek, Barrack Creek, Granite and Montrose Creeks low and below the DGV, and Mamelon and Neerim Creeks higher and above the DGV.

Turbidity shows a similar pattern to suspended solids, although in comparison to the DGV more sites are below the criterion – Deep Creek remains above, as do Mamelon, Neerim Creeks, and the dams.

Turbidity shows at times the expected behaviour in relation to rainfall and dry events, with low levels generally seen in dry periods in Tooloombah Creek, and in some dry periods in Deep Creek, followed by spikes in rainfall periods. In Deep Creek, the highest levels were seen in the middle of the 2018 dry season, which is not explained by the data, but perhaps reflects suspended fine sediments in still pools, and the effect of cattle access to these systems. Levels at St1 and St2 remained low throughout the monitoring period, other than a spike with the latest large wet season rains (January 2020), and a large rise at St2 in March 2012, which it is difficult to determine whether the result is genuine and if so, what the cause may be.

A boxplot summary of turbidity is shown in Figure 9-26, and further data included in the Surface Water Quality Technical Report in Appendix A5a.

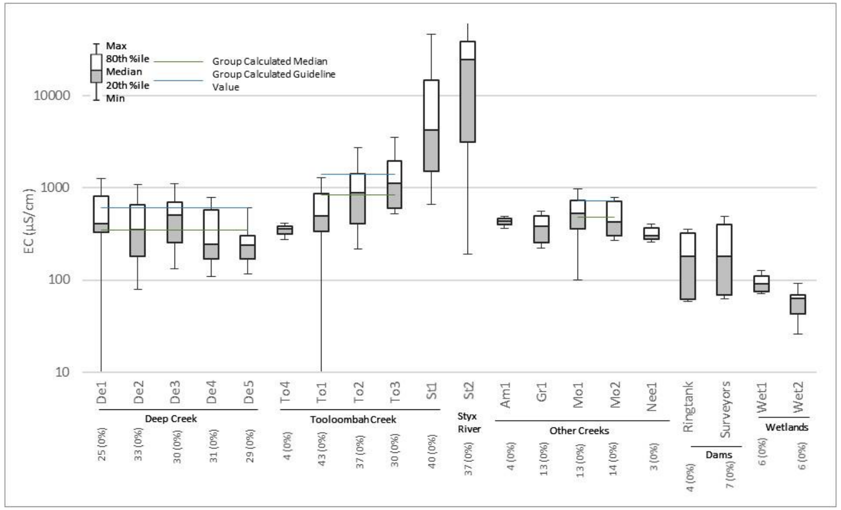

Figure 9-19: Boxplot of EC results by site

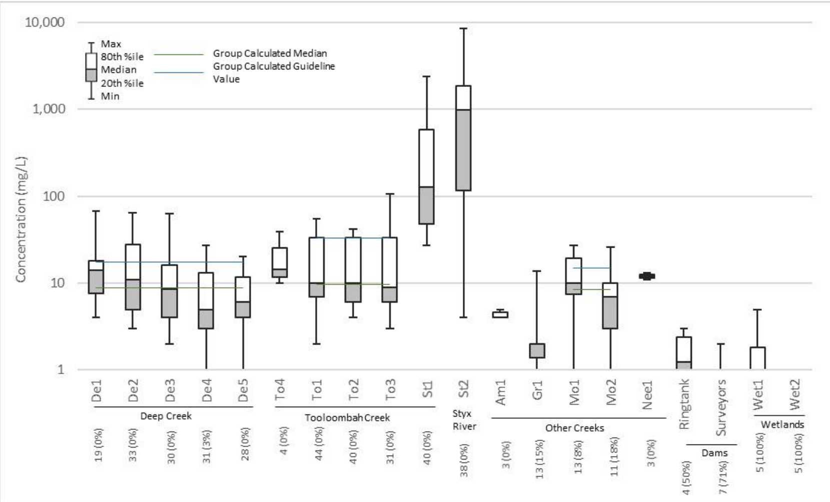

Figure 9-20: Boxplot of sulfate results by site

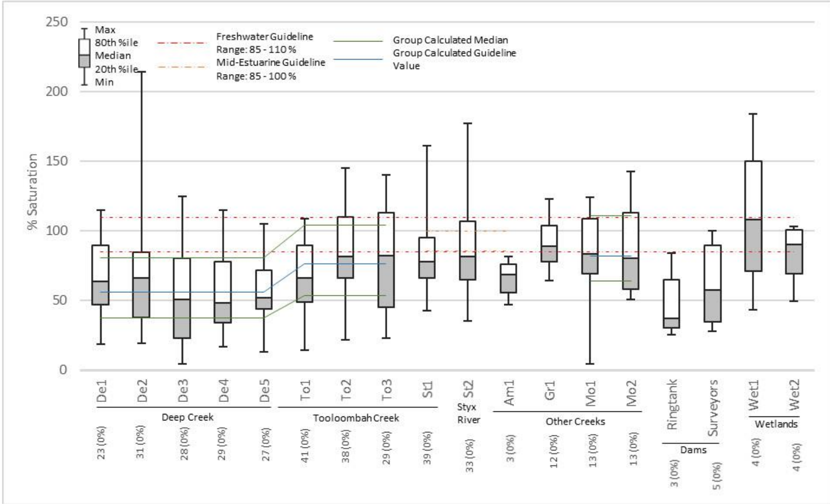

Figure 9-21: Boxplot of dissolved oxygen results by site

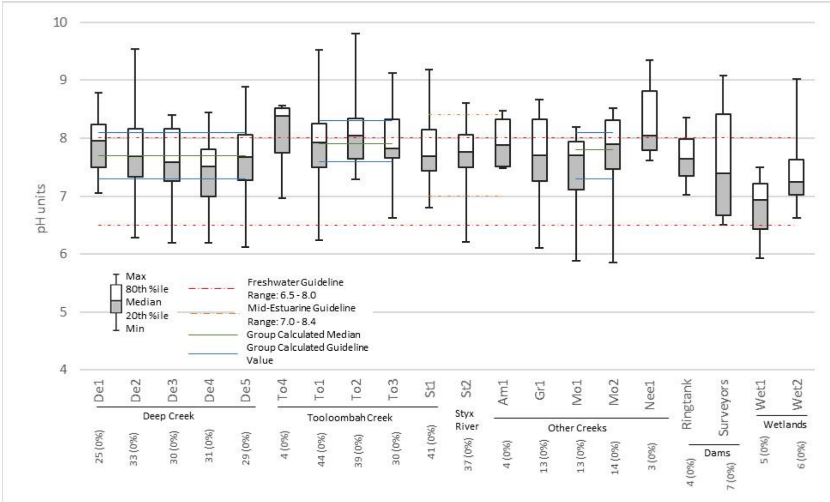

Figure 9-22: Boxplot of pH results by site

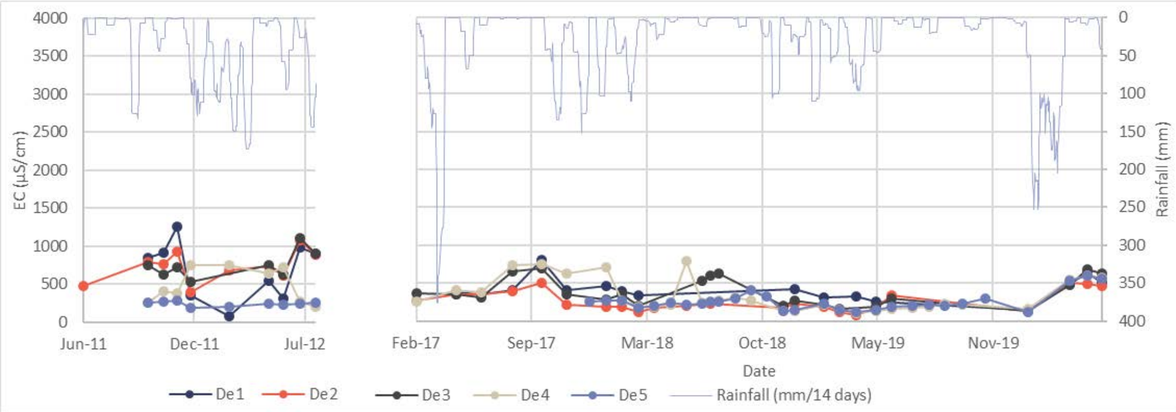

Figure 9-23: Timeseries of EC results, Deep Creek

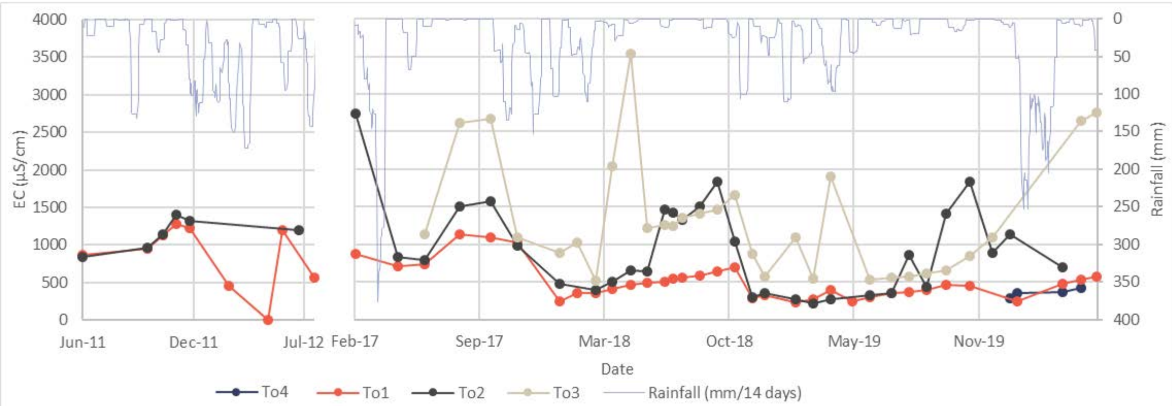

Figure 9-24: Timeseries of EC results, Tooloombah Creek

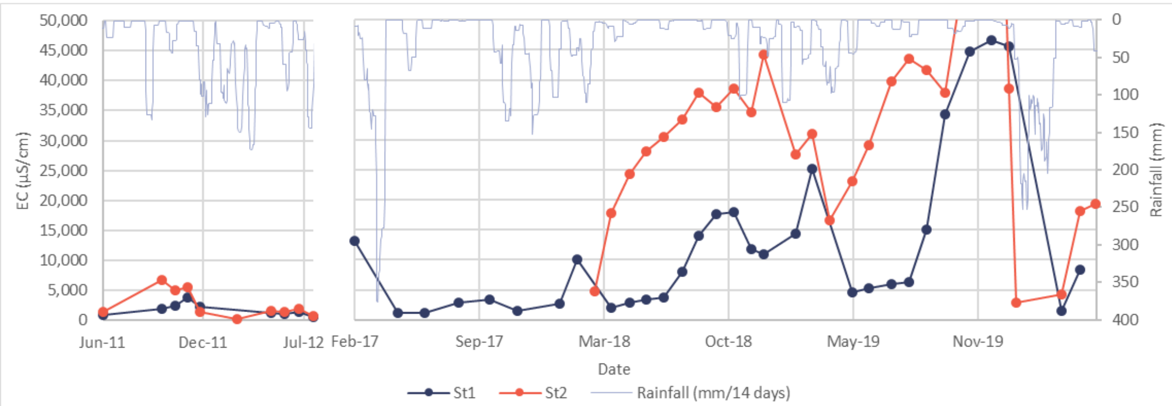

Figure 9-25: Timeseries of EC results, Confluence and Styx River

9.3.6.2.5 Nutrients

Nitrogen

All of the Deep Creek sites, plus To4, exceeded the DGV for total nitrogen, with the calculated 80^{th} percentile being above the DGV for all sites. Deep Creek was higher than Tooloombah Creek, with both De5 and To4 (in Tooloombah Creek) at the highest levels across the two creeks.

In terms of nitrogen species, all sites were above the DGV for ammonia, with a broadly similar pattern seen to total nitrogen between the sites. All sites were below the DGV for oxidised nitrogen, with the median being at or below the limit of reporting. However, the 80^{th} percentile was calculated for most of the sites showing a sustained drop in both Deep and Tooloombah Creeks between the upstream and downstream sites.

Over time, total nitrogen increases in response to rainfall, and appears to drop once rainfall ceases and still flow conditions prevail, with the effect more observable in Deep Creek than in Tooloombah Creek or the lower St1 and St2 sites, other than for the large January 2020 wet season event. Ammonia and oxidised nitrogen (as nitrate) appears to follow a similar trend, but less obvious for nitrate with many <LOR results.

Refer to Figure 9-27 for ammonia and Figure 9-28 for total nitrogen boxplot summaries, and Figure 9-30 to Figure 9-32 for total nitrogen over time in the following pages.

Phosphorous

As with nitrogen, Deep Creek has the highest total phosphorous levels, exceeding the DGV at all sites, although baseflow only results were all below the DGV other than for De5. In general, Tooloombah and the other creeks (Amity, Granite and Montrose) are relatively low and below the DGV.

Filterable reactive phosphorous, the most bioavailable form of phosphorous, was very low across all of the sites, with medians at or below the limit of reporting for all sites. The data shows broadly similar overall levels across all of the sites, with the Granite and Montrose Creek sites being higher than both Deep and Tooloombah Creeks.

Over time, similar rainfall induced peaks in total phosphorous are seen as for nitrogen, which are more pronounced in Deep Creek than Tooloombah Creek. The St1 and St2 sites are similar to Tooloombah Creek generally, although several spikes appear related more to levels within Deep Creek than Tooloombah at the time.

A boxplot summary of total phosphorous is shown in Figure 9-29, and further data included in Appendix A5a.

Summary

Taken together, the results for nutrients show a pattern of high nutrient levels in stormflow reflecting both runoff from the catchment and washout of stored nutrients in pool systems; lower total and ammonia levels in baseflows reflecting the system after this first flush, with nutrients retained in particulate form but loss of oxidised nitrogen stored up in the system during no flow periods (i.e. higher oxidised nitrogen in the water column); and finally elevated nutrients particularly ammonia when flows cease and particularly during extended dry periods in isolated pools, where organic matter is broken down, and altered sediment oxidation / reduction processes may release phosphorous into the water column. These no flow periods may be responsible for much of the nutrient processing within the catchment.

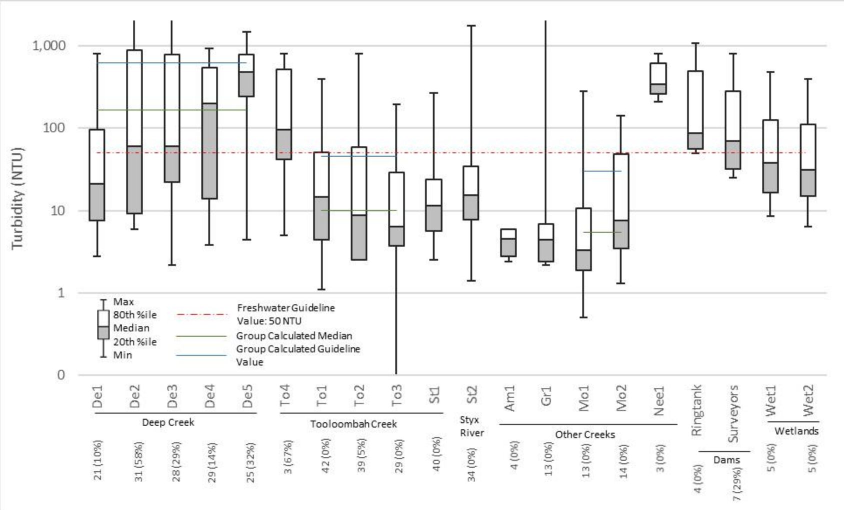

Figure 9-26: Boxplot of turbidity results by Site

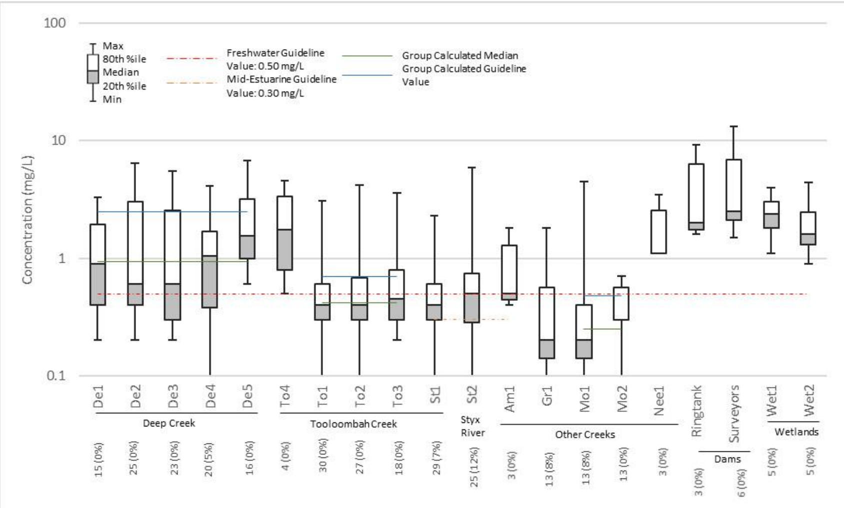

Figure 9-27: Boxplot of ammonia results by Site

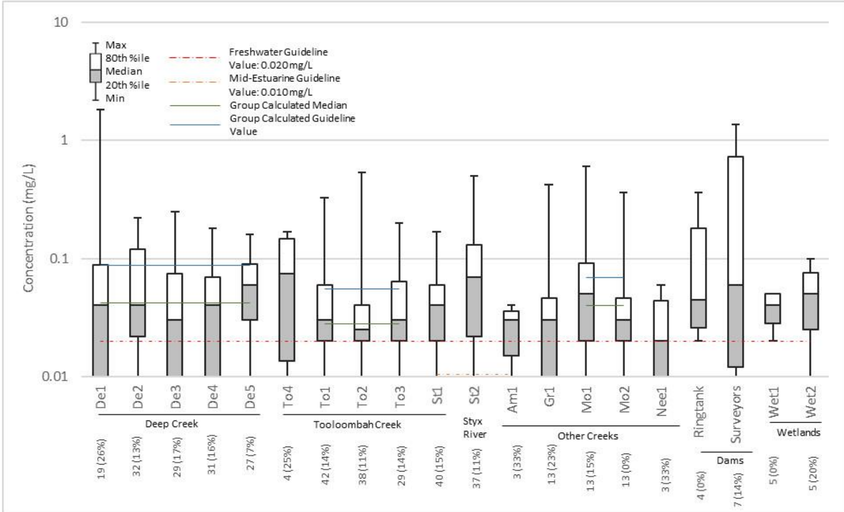

Figure 9-28: Boxplot of total nitrogen results by Site

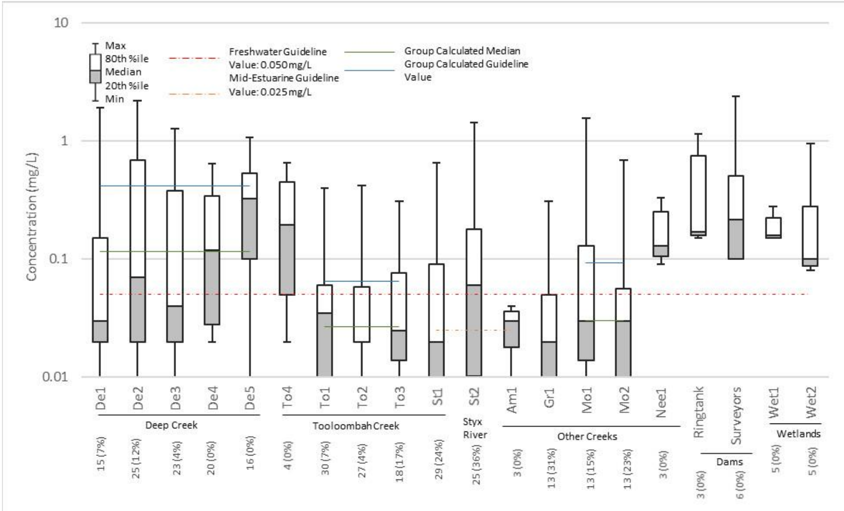

Figure 9-29: Boxplot of total phosphorous results by Site

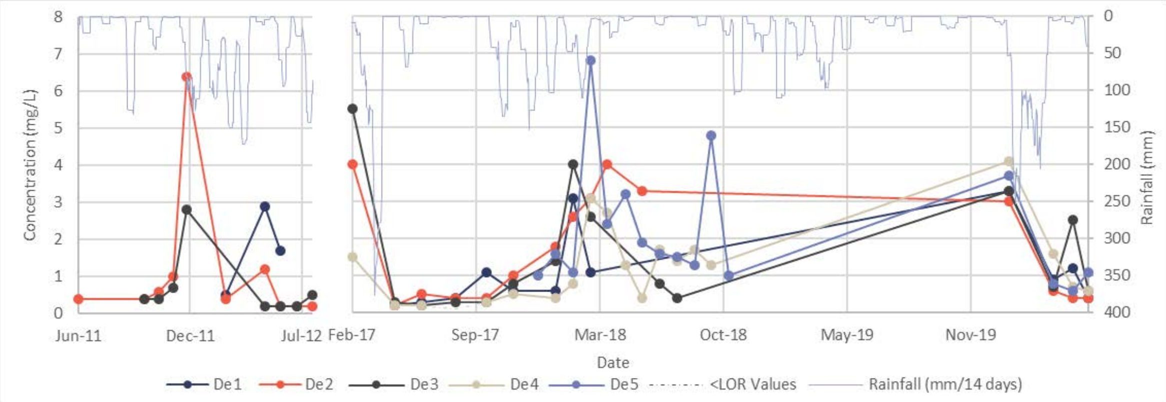

Figure 9-30: Timeseries of total nitrogen results, Deep Creek

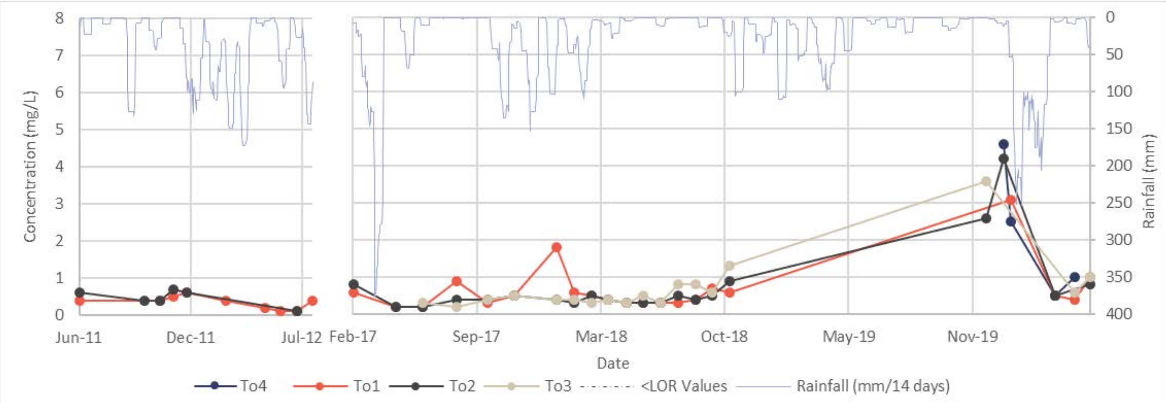

Figure 9-31: Timeseries of total nitrogen results, Tooloombah Creek

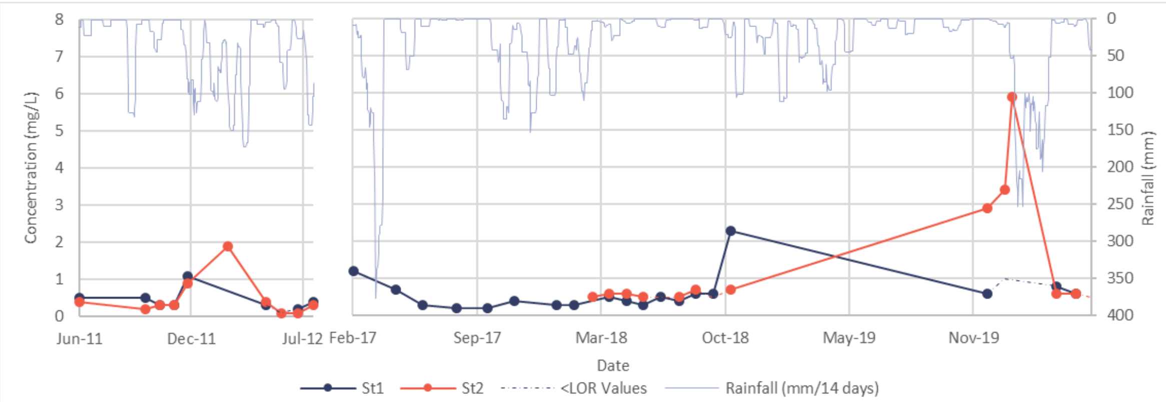

Figure 9-32: Timeseries of total nitrogen results, Confluence and Styx River

9.3.6.3 Isotope and Tracer Analysis

Stable isotopic analysis of surface water in several locations within both Tooloombah and Deep Creeks (De2, De3, De5; To1, To2, To3; a selection of nearby groundwater bores) was undertaken in July 2018. The results indicate that the water at these locations undergoes evaporation (i.e. it is progressively enriched with heavier isotopes). However, radioactive isotope results and relative comparison to chloride and bicarbonate/chloride concentrations indicated that there is a potential for groundwater contributions to Tooloombah Creek, more so than Deep Creek, albeit potentially not in any significant quantities.

The indications from this data are that there is generally limited groundwater contribution from the water table, but it does appear to occur in some areas, more so in Tooloombah Creek, but to a limited degree.

9.3.6.4 Sediment Loads

The 2017 'Scientific Consensus Statement 2017: A synthesis of the science of land-based water quality impacts on the Great Barrier Reef' (Bartley et al. 2017) provides the monitored annual average total suspended solids (TSS) load from the Fitzroy catchment at 2,300,000 tonnes (t) at the Fitzroy River gauging station at Rockhampton, and a modelled rate of total TSS load exported to the coast for the Styx catchment of 100,000 t/year, or around 4% of the total Fitzroy catchment.

A sediment budget assessment undertaken for the Project by Engeny Water Management provided in Appendix 15b, estimates a total baseline sediment export rate of 5,037 t/year for the Project area, comprising the Mamelon Property (including but not limited to ML80187) and ML700022. This equates to 0.72 t/ha/year based on the predominant grazing land use for the area (the above lower rate incorporates non-grazing areas in the Styx basin).

9.3.7 Wetlands and Farm Dams

Wetlands are defined by the Queensland Department of Environment and Science (DES) as 'Areas of permanent or periodic/intermittent inundation, whether natural or artificial, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 m (DES 2015).

There are three types of wetlands that have been identified within the Project area and surrounding areas:

- Riverine - Riverine wetlands are those systems that are contained within a channel (e.g. river, creek or waterway) and their associated streamside vegetation.
- Lacustrine - wetlands within a topographic depression or dammed river channel that cover an area greater than 8 ha without persistent emergent vegetation and include dams.
- Palustrine - wetlands dominated by persistent emergent vegetation and include swamps, bogs, and billabongs.

There are two mapped wetlands located in the Project area within the Tooloombah Creek catchment that are specified under the *Vegetation Management Act 1999.* The more southern ('Wetland 1'), has been mapped as a Wetland Protection Area whilst the more northern of the two ('Wetland 2'), has been mapped under the Department of Natural Resources, Mines and Energy (DNRME) vegetation mapping. Several lakes and rural water storage dams on either side of the Bruce Highway alignment are also mapped as artificial wetlands by DES. These are shown in Figure 9-9.

Refer to Chapter 15 – Aquatic and Marine Ecology for further information and assessment of wetlands.

There are four existing farm dams of varying size within the Project area. These dams are predominantly used for stock water, are highly disturbed and do not support vegetation communities. There is also catchment contouring within the Mamelon property to the south of the Bruce Highway for capturing and storing overland runoff and preventing erosion.

Water quality has been collected in several of these dams from late 2019 to May 2020, with two sites – the Ringtank and Surveyors dams – having sufficient data to generate interim statistics. The results (refer to the Surface Water Quality Technical Report in Appendix A5a) indicate farm dams have high nutrient levels, low dissolved oxygen, slightly elevated turbidity, but fresh (low EC) slightly above neutral (pH 7.5) water. Aluminium, copper, iron, nickel and zinc were above the aquatic ecosystem guideline values, primarily at the Ringtank site rather than Surveyors.

9.3.8 Existing Water Users

The Project is predominately situated within the Mamelon cattle grazing property, which runs cattle and produces dryland crops. The Mamelon property is owned by CQC and is currently being leased for these uses. Supporting this land use is a series of farm dams and surface contour bunds that capture and store runoff generated by the local contributing catchments. Groundwater bores also lift water to dams and/or storage tanks in the surrounding region for domestic and stock water use (see Chapter 10 - Groundwater for a reference to registered and unregistered bores).

There are several surface water entitlements in Tooloombah and Deep Creek for irrigation, stock and domestic supply, summarised in Table 9-7. The entitlements that may be impacted by the Project by being located adjacent to or downstream of operations include the following:

- Authorisation 57489U, Lot 119 on CP900367 - Irrigation entitlement located on parcel of land adjacent to the Mamelon property, separated by Deep Creek, and approximately 3 km downstream of mine infrastructure and environmental dam release point locations on Deep Creek.
- Authorisation 34978U, Lot 1 on RP616700 and Lot 19 on MC495 - Domestic / stock supply entitlement located on parcel of land adjacent to the Mamelon property and straddling Tooloombah Creek. The extraction point appears to supply a small off-stream storage on the western overbank of Tooloombah Creek, on the Bar-H property.
- Authorisation 57490U, Lot 45 on MPH26062 - Irrigation entitlement on parcel of land directly bordering the Project lease boundary to the north and extracting approximately 6 km downstream of the Bruce Highway on Tooloombah Creek.

Table 9-7: Water entitlements for waters associated with the Project

Auth No.	Water Source	Location	Authorised Use	Entitlement Per Water Year	Maximum Extraction Rate	Water Type
57489U	Deep Creek	119/CP900367	Irrigation	20ha	-	Watercourse
34978U	Tooloombah Creek	19/MC495, 1/RP616700	Domestic Supply, Stock	18ML	-	Watercourse

Auth No.	Water Source	Location	Authorised Use	Entitlement Per Water Year	Maximum Extraction Rate	Water Type
57490U	Tooloombah Creek	45/MPH26062	Irrigation	8ha	-	Watercourse
57526U	Tooloombah Creek*	633/MC630	Irrigation, Stock	3 ha	-	Watercourse

Table notes:
* Located upstream of the Project

The Ogmore Water Supply System provides non-potable water to the Ogmore township, sourced from Montrose Creek and located northwest of the Project. Water is stored in four reservoirs with a total capacity of 88,000L. The creek water is typical of an unprotected surface water catchment and is not suitable for potable uses unless treated.

9.3.9 Estuarine and Marine Areas

The Styx River catchment discharges directly into Broad Sound, an extensive coastal embayment within the GBR World Heritage area, which is listed in the Directory of Important Wetlands of Australia. It contains Australia's largest FHA, declared under the Queensland *Fisheries Act 1994*.

There are a number of important environmental values in the downstream marine area, including:

- Broad Sound Wetland, listed on the DIWA
- Broad Sound FHA
- the Great Barrier Reef World Heritage Area
- the Great Barrier Reef Marine Park and Great Barrier Reef Coast Marine Park
- habitat for marine species and communities, including marine plants and listed threatened and migratory species and
- a number of sites within Broad Sound that are considered to be of national and international importance for migratory shorebirds.

A water quality and ecology assessment was conducted in the Styx River estuary, and nearby Waverley and St. Lawrence Creek estuaries in 2011 by ALS (refer to the estuarine benthic study in Appendix A10i).

Water within the Broad Sound region is naturally turbid due to the extreme tidal range over a large shallow area, resulting in strong currents and the resuspension of sediments. Nutrient and chlorophyll concentrations are generally low.

The Styx River Estuary and Broad Sound contain a variety of marine habitats, with mangroves being the dominant value within the estuary, providing important habitat to fish and other marine fauna. Saltmarsh also occurs in patches in the upper range of the inter-tidal zone, but is not likely to be sensitive to Project-related impacts. There are no known seagrass beds in close proximity to the Project, likely due to the high turbidity of estuarine waters, and large tidal range of Broad Sound.

Further information on the aquatic ecology of estuarine and marine areas is provided in Chapter 15 – Aquatic and Marine Ecology.

9.4 Water Management System

9.4.1 Overview

An updated Draft Site Water Management Plan for the Project has been prepared, detailed in Appendix A5c - Draft Water Management Plan, with the technical supporting assessment detailed in Appendix A5b - Flood Study and Site Water Balance Technical Report. The water management system aims to manage water quality and quantity so as to:

- minimise the risk of uncontrolled discharges from the mine water management system
- ensure the site has sufficient water available for operation in dry times and
- ensure no adverse impact on receiving water quality.

The proposed water management strategy for the Project is based on targeted management of water from different sources based on anticipated water quality. The categories of water and specific objectives for each type are summarised in Table 9-8.

Table 9-8: Summary of water management system

Water Type		Management Objectives
Clean water	Surface runoff from undisturbed catchment areas	• Separate from the mine affected and sediment water systems as much as practicable and allow it to pass uninterrupted through the catchment
Mine affected water	Seepage, groundwater and surface runoff inflows to the open cut mining areas which could potentially have elevated salinity	• Contain within the site water management system. • Ensure any controlled releases do not result in environmental harm. • Minimise uncontrolled discharges in wet periods to protect downstream water quality and ensure adequate water supplies are maintained for site demand during dry periods.
Sediment laden water	Surface runoff from overburden emplacement areas and other non-mining disturbed areas which is likely to have high concentrations of suspended sediment	• Contain within the site water management system and recycle to meet site water demands. • Treated to remove sediments to a level suitable for release.
Contaminated water	Water from workshop or fuel storage areas that may have elevated oil, grease and other contaminants	• Ensure full separation from other water sources and manage under the specifications of AS1940 - Storage and Handling of Flammable and Combustible Liquids.

9.4.2 Water Supply and Demand

Water supply for the Project will be sourced from Dam 1, which sources water from natural catchment runoff, groundwater and rainfall from pit dewatering, and water captured in other site storages, including sediment dams.

Although the EIS and SEIS v1 and v2 previously reported water permits will be sought to take water from Tooloombah Creek during construction, this will not be necessary. Since the release of the EIS, further water demand assessment has been undertaken and the water storage network within the Project has been revised. This assessment has confirmed that there will be adequate water availability through the proposed Dam 1 (refer to Section 9.6.3.1). Minor amounts of water will be sourced for potable supply and on-site farm dams used for dust suppression as needed prior to completion of site water storages to supply water for construction use.

Geochemical characterisation presented in the Geochemical Assessment of Waste Rock and Coal Reject in Appendix A3b concluded that the overwhelming majority of the waste rock and potential coal reject materials have a very low risk of acid generation, and runoff from waste rock and coal rejects would be alkaline and have a low level of salinity. Dissolved metal/metalloid concentrations are expected to be low and unlikely to pose a significant risk to the quality of surface and groundwater resources in site storages. As such, water is anticipated to be of good quality for reuse on the site.

Fine rejects from the fines coal circuit will be dewatered at the Coal Handling and Preparation Plant (CHPP) using belt press filters, with the extracted water recycled back into the CHPP water circuit at an effective decant return rate of about 82%. This significantly reduces the net CHPP makeup water from a gross requirement of approximately 208 L/ROM tonne to approximately 81 L/ROM tonne. During years 11 and 12, approximately 1Mt and 4Mt of the Run of Mine (ROM) coal will be bypassed, respectively. This bypassed coal will not require washing at the CHPP[10].

Water for haul road dust suppression and service water (for vehicle washdown, fire water demand and ROM pad dust suppression) will be sourced from Dam 1. Daily haul road dust suppression watering rates were estimated based on haul road surface area and daily rainfall and evaporation rates. Service water demand is estimated at 50 ML/a across all mine stages.

Potable water will be sourced from groundwater or raw water supplies (Dam 1) and treated in an on-site batch Water Treatment Plant (WTP) to drinking water standards. An annual demand of 6.3 ML/a has been assumed.

Annual water demand estimates are provided in Table 9-9, based on the five stages used in the water balance modelling (note potable water is excluded as it may not be sourced from mine water management system).

Table 9-9: Average annual water balance

Component	Process	Average Annual Volume (ML/a)				
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Inflows	Catchment runoff & direct rainfall	1,510	1,623	2,147	2,539	2,680
	Groundwater inflows	310	274	46	0	0
	External supply (demand shortfall)	29	26	88	91	32
	Total inflows	***1,849***	***1,923***	***2,281***	***2,630***	***2,712***
Outflows	Evaporation	746	871	912	965	1,252
	Dust suppression	436	438	596	596	596
	CHPP makeup demand	178	324	324	323	168
	Service water demand	50	50	50	50	50
	Spillway overflows: mine water dams	5	7	2	98	83

[10] Appendix A5b states that 3Mt and 6Mt will be bypassed, however refinements to this quantity have been made recently. The additional water demand represents a 15% water increase for those years. This would reduce overflow risk, and where supply risks occur, additional bypass can be adopted as needed (refer Section 9.7).

Component	Process	Average Annual Volume (ML/a)				
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
	Spillway overflows: sediment dams	3	5	60	57	58
	Controlled releases	295	226	285	383	407
	Total outflows	1,713	1,921	2,229	2,472	2,614
	Change in volume	***136***	***2***	***52***	***158***	***98***

The water demand for rehabilitation and mine closure during Years 19 to 24 will likely be significantly lower than the demands during the operations of the mine. Water demands during rehabilitation stages is assumed to be 20 ML sourced from environmental dams and pit dewatering and will be finalised during detailed design.

Groundwater inflows have been sourced from the groundwater modelling assessment (Appendix A6b) as shown in Figure 9-33. The total gross inflows into Open Cut 1 and Open Cut 2 peak at 1.1 ML/a in Year 4 as shown in, showing the total inflow (total flowing into the pit), and net inflow (total flow less face evaporation and similar losses).

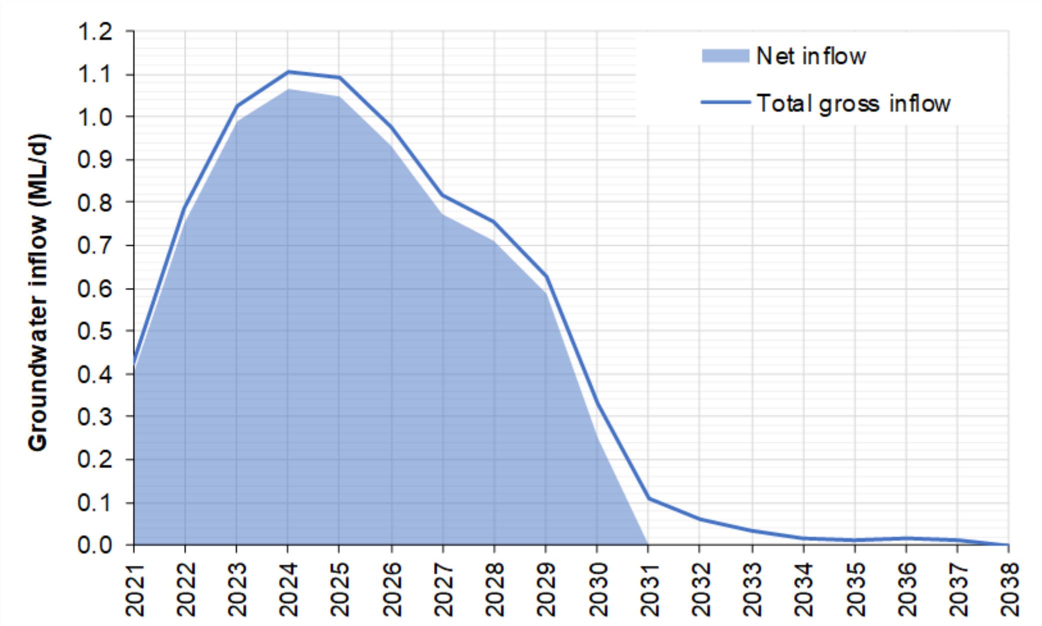

Figure 9-33: Estimated groundwater inflows (WRM 2020)

9.4.3 Water management infrastructure

9.4.3.1 Overview

The site water management system involves the following key infrastructure, and is shown in the schematic in Figure 9-34 and in the site layout in Figure 9-35, with the potential release points shown in Figure 9-36:

- A large (2,783 ML) mine water dam (Dam 1) which is the main storage for runoff from active mining areas and groundwater inflows to the open cut pits. Dam 1 will also collect undisturbed catchment runoff in the early stages of the Project to provide water supply for mining operations.

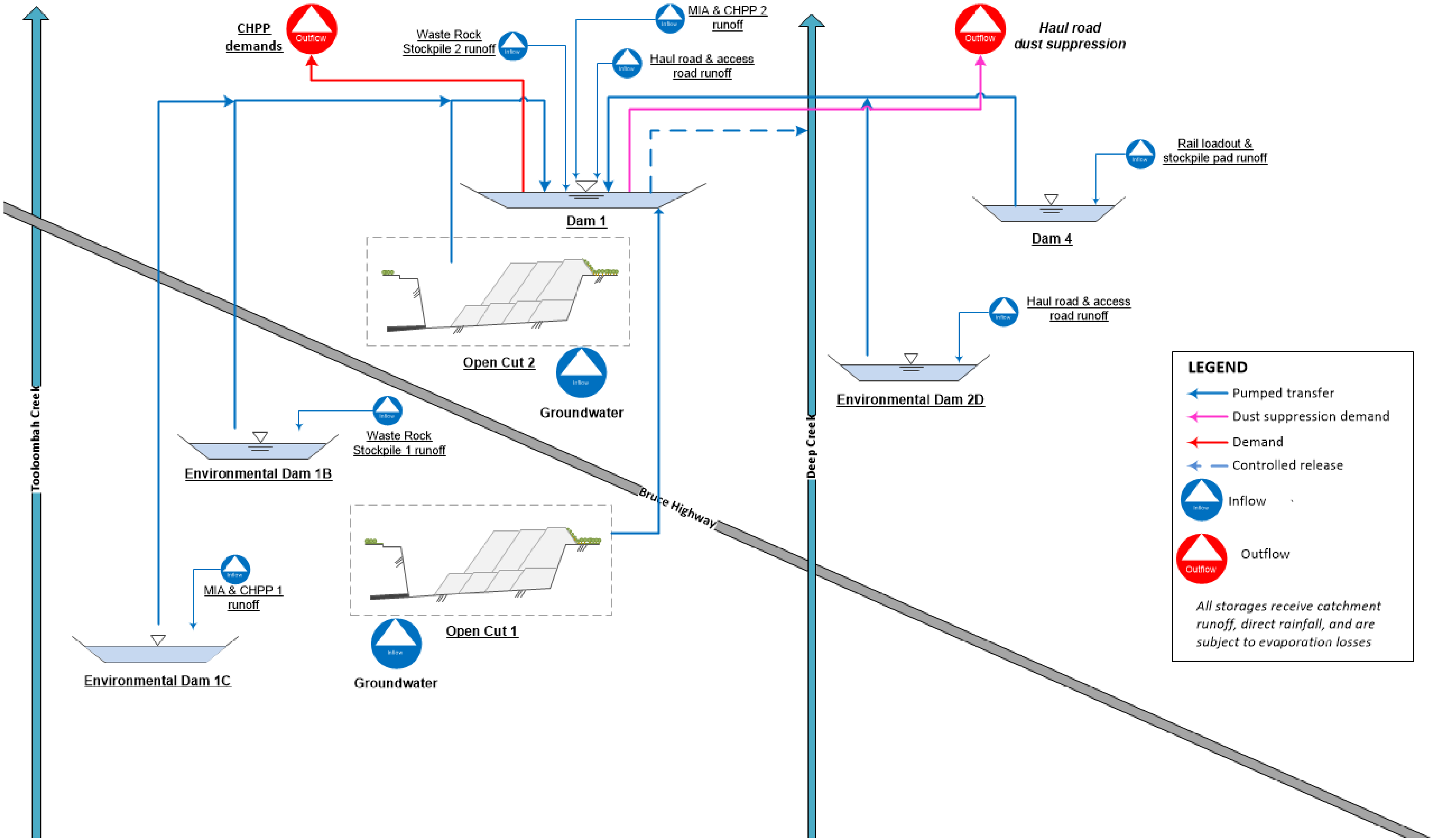

Figure 9-34: Proposed water management system configuration

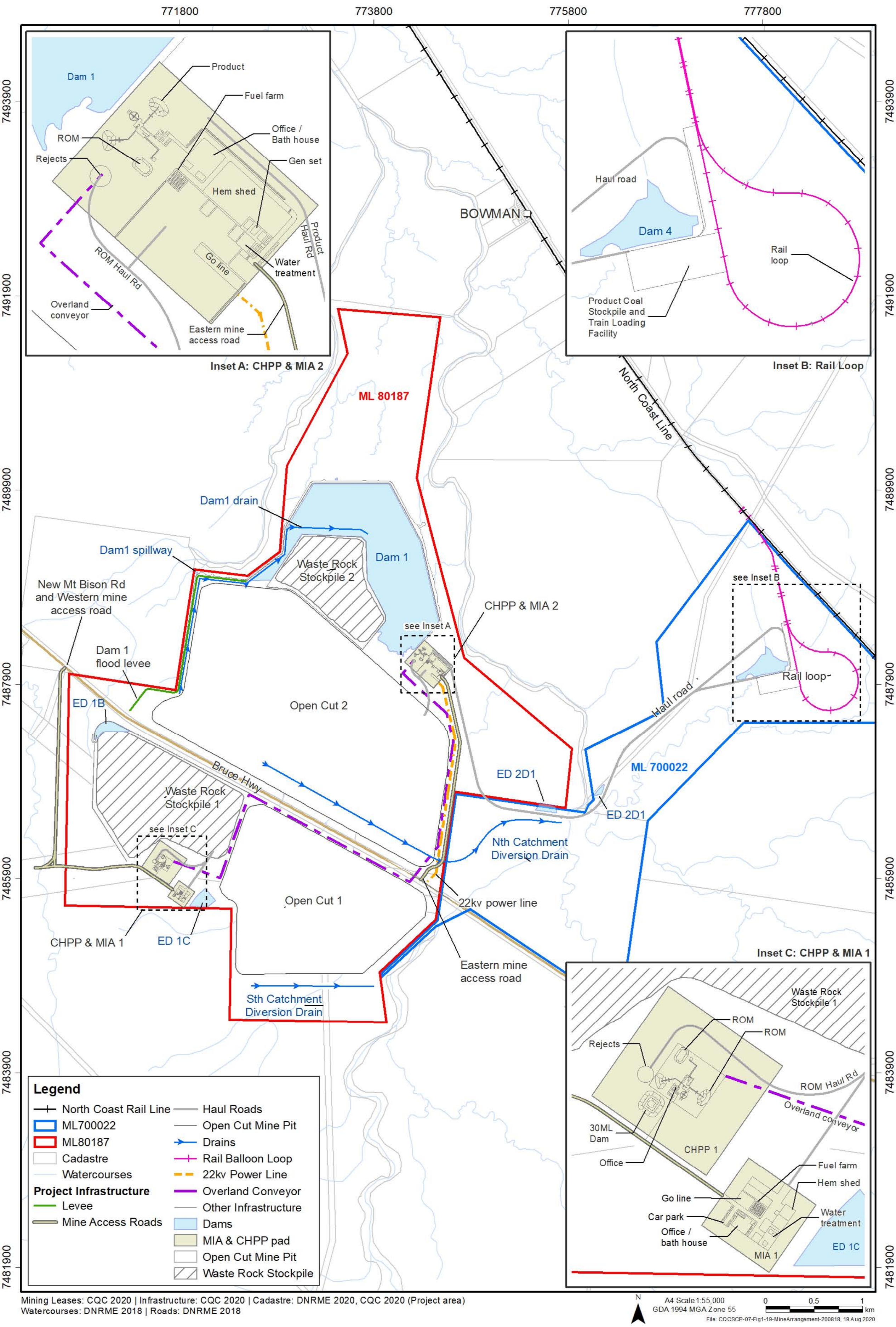

Figure 9-35: Site layout plan

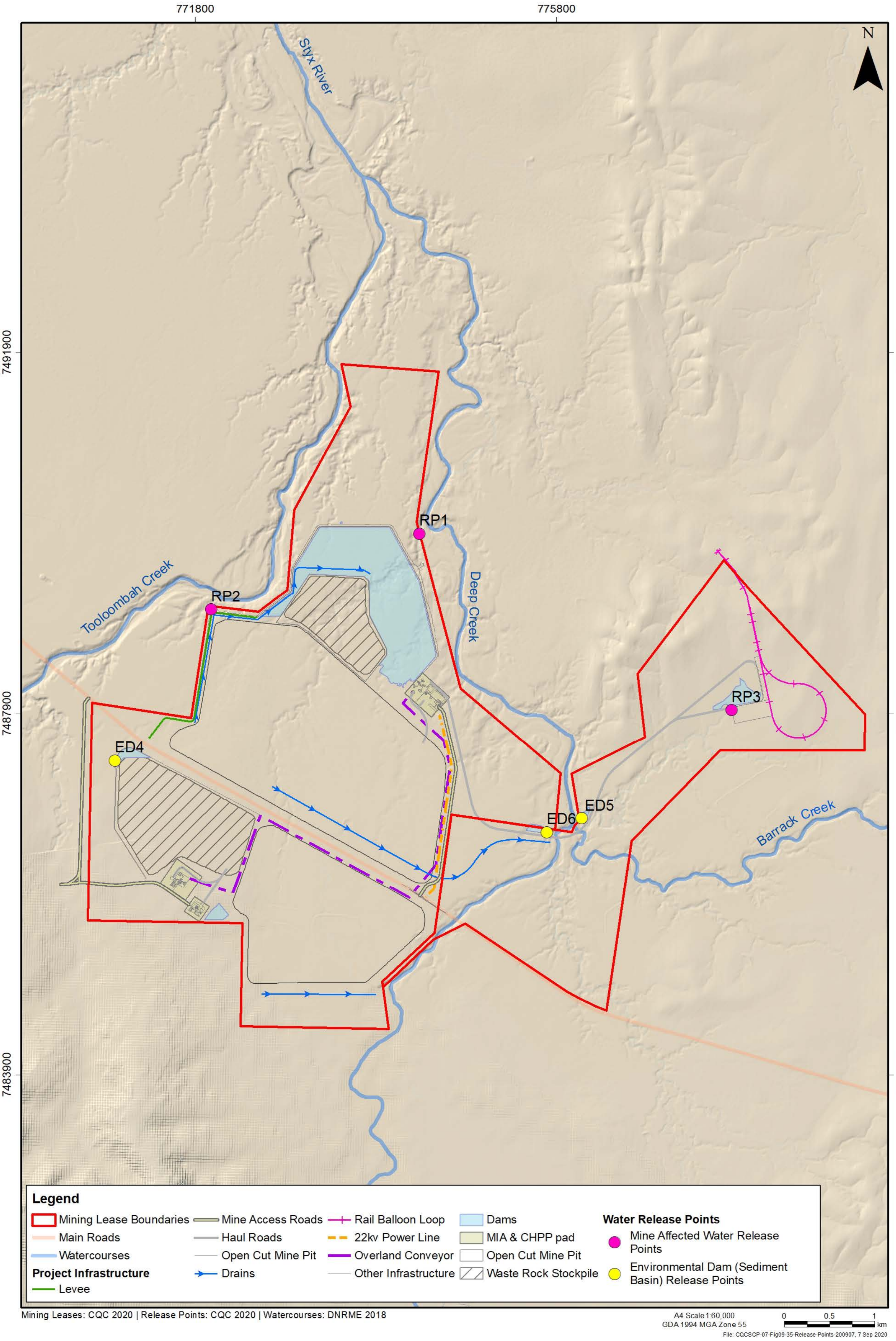

Figure 9-36: Site water release points

- A controlled release system from Dam 1 to Deep Creek. The controlled release system will enable site water volumes to be managed during wet periods when significant inflows to the site water management system are expected. Releases will only occur during flow events in Deep Creek.
- Two clean water diversion drains
  - the Northern Catchment Diversion Drain, located north of the Bruce Highway, to divert clean catchment runoff around Open Cut 2 to Deep Creek, operating from the start of mining up to Year 12 when it will be largely mined out (and the remainder rehabilitated) and
  - the Southern Catchment Diversion Drain, located south of the Bruce Highway, to divert clean catchment runoff around Open Cut 1 to Deep Creek, operating from Year 10 until the end of mining.
- Sediment dams to collect and treat runoff from the overburden emplacements and haul roads
  - Environmental Dam 1B, collecting runoff from Waste Rock Stockpile 1, located south of the Bruce Highway and
  - Environmental Dam 2D (2D1 and 2D2), collecting runoff from the haul road to the Train Loadout Facility (TLF), with any overflows to Deep Creek.
- Dam 4, an environmental dam to collect and contain runoff from the haul road, rail loop and train loadout facility, including product coal stockpile, draining to a tributary to Deep Creek.
- Environmental Dam 1C, to contain runoff from Mine Infrastructure Area (MIA) and CHPP 1 south of the Bruce Highway, draining to Dam 1 (though designed with sufficient emergency storage to avoid overflow).
- Pumps and pipelines and ancillary equipment to transfer water around the site.

Details of the dams are provided in Table 9-11.

9.4.3.2 Controlled Release Structure

The configuration of the outlet will be determined during detailed design; however, it is likely to comprise a number of discharge pipes through the dam wall (nominally 4 x 900mm dia.), with remote controlled valves to enable optimum discharge timing. The outlet will be designed with scour protection and energy dissipation to ensure safe and stable releases.

9.4.3.3 Dam 1 Spillway

The Dam 1 spillway has been located on the western side of Dam 1, with overflows occurring over the levee wall by way of a constructed and stabilised spillway into Tooloombah Creek adjacent to the site. Detailed design for this system is yet to be finalised, and another location for the spillway has also been investigated, located on the western end of the northern Dam 1 wall, discharging to Tooloombah Creek slightly downstream from the site. This is shown in Figure 9-37. For the purposes of this SEIS, the westernmost location is the relevant location.

In accordance with the results of the regulated structures assessment (Section 9.4.7), Dam 1 will require a spillway to have capacity to pass the 0.1% AEP event.

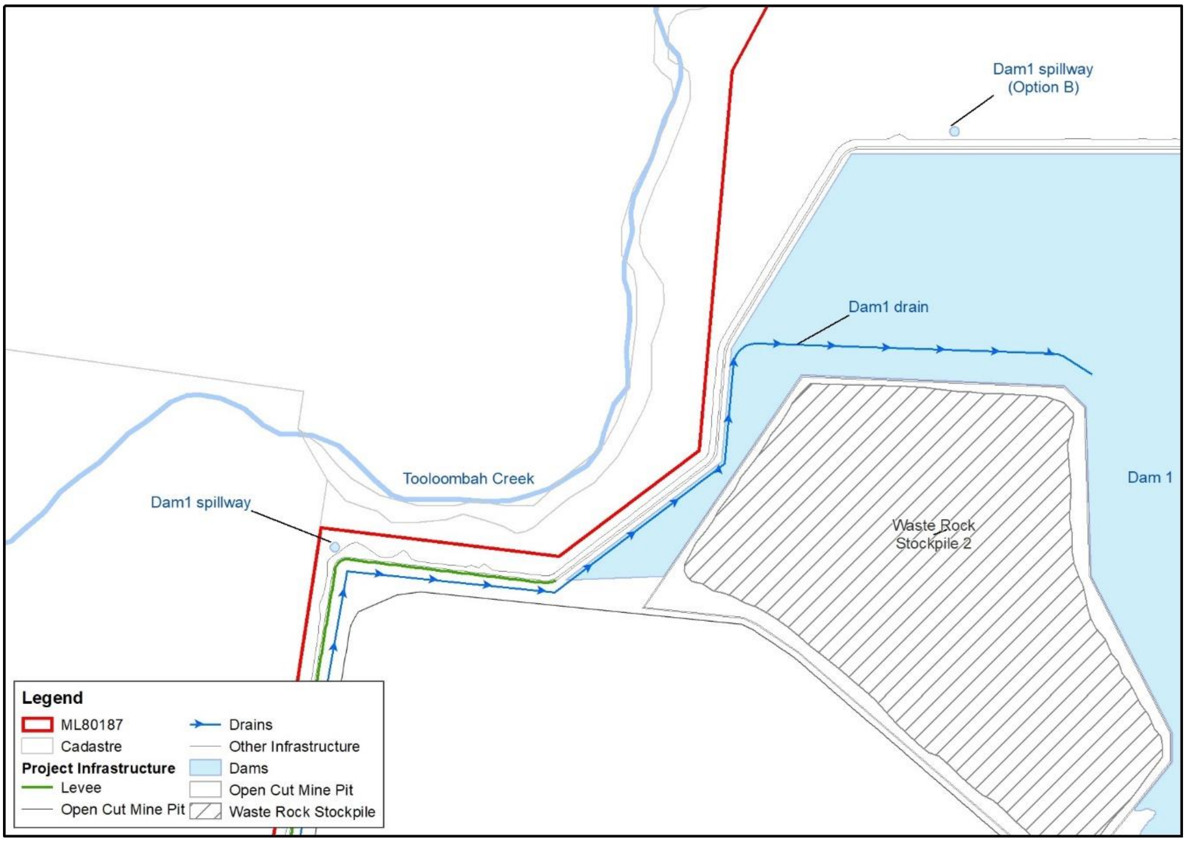

Figure 9-37: Dam 1 spillway location

9.4.3.4 Environmental Dams

Environmental dams are sized based on the 9.5% AEP, 24 hour rainfall event. Water captured in the environmental dams will be preferentially used in the mine operations, at the MIA, CHPP and for dust suppression. Otherwise, these dams will be operated empty, dewatered to Dam 1.

Environmental Dams 1B, 2D1/2 and Dam 4 will have a low flow perforated riser-pipe decant outlet to discharge treated water to the receiving environment as controlled discharges when the dam cannot be transferred instead to Dam 1. Dam 4 will be via an authorised release point, and the others will be managed as part of the site Erosion and Sediment Control Plan (ESCP).

Environmental Dam 1C is not designed to drain off-site, incorporating a design storage allowance and minimal catchment to ensure overtopping does not occur.

Spillways for Environmental Dams will be designed to have capacity to pass the 0.1% AEP event.

9.4.3.5 Clean Water Diversions

Diversion drains and bunds are proposed to divert clean water runoff around the mine affected areas, including the open pits and waste areas. This clean water is diverted away from mine-affected or sediment affected water which is captured in environmental dams.

Two catchment diversion drains are proposed – one on the north of the Bruce Highway to divert upslope catchment waters away from Open Cut 2 and the Dam 1 catchment, reducing water inventory and therefore discharge risk. The other is located on the southern side of the Bruce

Highway to likewise divert upslope waters around Open Cut 1, to be constructed in Year 10 (the northern drain is fully mined out by Year 13/14).

9.4.3.6 Levee

A levee wall has been incorporated into the site design for the Project north of the Bruce Highway, extending from the western end of Dam 1 another 2.3 km south and west to near the Bruce Highway, providing flood protection and containment of potentially contaminated waters on-site. The levee structure is part of the Dam 1 wall, and due to other constructions on the site, the flood protection effectively extends around MIA / CHPP 2 and along the entrance road to near the Bruce Highway on the eastern side of the Project.

9.4.3.7 Site Stormwater Drainage

The major elements of the site water management system have been described above. For the minor components and in-site drainage elements, a concept site stormwater plan was prepared for the previous SEIS v2 in keeping with the DES *Stormwater Guideline* (EHP 2014b). The current updated mine layout has adopted the same approach, with design details for elements of the system shown in the construction plans in Appendix 16 of this SEIS v3. However, the detail that was included in the SEIS v2 has not been replicated herein.

The site stormwater system will be updated as detailed design progresses post approval, and general details of the plan are as follows:

- Open Cut pits will utilise bund and diversion drain systems along the edge of the pit to divert local stormwater away from the pit, sized to divert the 0.1% AEP event. These will move with the pits as they change as necessary.
- Site drains for waste rock stockpiles, MIA, CHPP and the like will incorporate a 9.5% AEP design capacity, with runoff directed into environmental dams. Local clean water diversion drains will be constructed to a similar standard where required.
- Table drains will be constructed along haul roads and conveyed longitudinally towards culvert structures by way of sediment structures (such as Environmental Dams 2D1 and 2D2). In areas of steeper grade, sediment transport can be effectively managed using check-dam structures within the drain. Where haul roads cross drainage gullies or the Deep Creek watercourse, an appropriately sized culvert will be provided, allowing for fish passage where relevant.
- Crossings are conceptualised as box culvert crossings with capacity to pass a minimum 9.5% AEP design discharge. Discharges above the design event will pass over the box culvert as a floodway-type arrangement, efficiently passing flows over the road while minimising impacts on local flood depths and velocities, as well as impacts associated with rising headwaters upstream of the culvert crossing.

9.4.3.8 Wastewater

Sewage wastewater will be generated on the site from personnel attending the site. As proposed in the SEIS v2, this will be collected in on-site storages (septic tanks or similar) and trucked off-site for treatment and disposal. No on-site wastewater treatment and irrigation scheme is proposed.

Minor amounts of waste oils or other chemicals will be generated on the site. This will be contained and removed off-site for recycling, treatment and/or disposal at appropriately licensed premises. Oily or fuel contaminated water from bunded areas (fuel farms, vehicle washdown, etc.) will be treated through triple interceptor type arrangements, with the treated water directed to the site water management system, and the collected contaminants likewise removed off-site for recycling, treatment and/or disposal at appropriately licensed premises.

9.4.3.9 Proposed Authorised Release Points

The proposed authorised release points are summarised in Table 9-10.

Table 9-10: Proposed authorised release points

Release Point	Easting	Northing	Water source and location	Monitoring point	Receiving waterway
RP1	774303	7489580	Dam 1 Controlled Release Waste Rock Stockpile 2, CHHP2 and associated MIA area, haul road, access road. Sources water from Open Cut 1 and 2, Environmental Dams 1B, 1C, 2D and Dam 4.	Sampling tap on riser pipe outlet	Deep Creek
RP2	771975	7489055	Dam 1 Spillway As above	As close as practical to the spillway in Dam 1	Tooloombah Creek
RP3	777740	7487943	Dam 4 Rail loadout and product stockpile pad, haul road	Sampling tap on riser pipe outlet	Deep Creek tributary

9.4.4 System Operation

The water management system has been modelled by WRM Water and Environment, with the operating rules described in the draft Water Management Plan in Appendix A5c, and the modelling provided in the Flood Study and Site Water Balance Technical Report in Appendix A5b. The key elements of the system are detailed in Table 9-11.

In summary, the water management system is designed to operate as follows:

- Dam 1 is operated as the primary water storage on the site, with all mine affected water including pit dewatering collected in Dam 1, or pumped from other storages. Other sediment basins are also dewatered to Dam 1 as needed.
- Dam 1 supplies all site water needs, with potable water potentially sourced from Dam 1 or groundwater supplies.
- Controlled releases from Dam 1 to Deep Creek are proposed during wet conditions to prevent excessive accumulation of water within the site storages and minimise the risk of uncontrolled discharges.
- Spillways are provided on all dams, and overflows may occur from Dam 1, from Dam 4 and from the other sediment basins, although generally the smaller dams are operated empty by dewatering back to Dam 1. Environmental Dam 1C is designed with significant overflow protection storage, and drains to Dam 1.

- A pump and pipe system connects all of the water dams to enable movement of water where it is needed on the site. In general, mine affected water will be prioritised for reuse over cleaner water sources.
- Two diversion drains are proposed to be implemented to divert clean upslope catchment runoff around the mine site.
- Oil / water separators are proposed for vehicle wash and workshop areas to treat hydrocarbon contaminated runoff prior to release or containment in environmental dams.

Table 9-11: Proposed infrastructure details

Infrastructure	Details	Management / Operating Rules
Open Cuts		
Open Cut 1 and 2	Open cut mining operations, capturing groundwater inflow / dewatering water and rainfall, requiring draining for mining	Dewaters to Dam 1, allowing for a nominal 50ML sump volume within each pit.
Dams and Levees		
Dam 1	Mine affected water dam Full Supply Storage: 2.783 ML Operating Storage: 1,800 ML Area: 128 ha Wall height: generally <10m, require detailed design to determine in all areas	Operated as the primary mine affected water storage for the Project, and receives all mine affected water on the site, and additional water from sediment dams and clean upslope water. It captures runoff directly from Waste Rock Stockpile 2, MIA and CHPP 2, part of the haul road and northern access road, and upslope clean water, and sources water from the other dams. Water is supplied from Dam 1 to meet CHPP demands, haul road dust suppression, vehicle washdown and fire water Controlled releases are required to Deep Creek, from a controlled release structure in the north-east of Dam 1. Where capacity is exceeded, Dam 1 would overflow to Tooloombah Creek.
Environmental Dam 1B	Sediment dam Full Supply Storage: 23.7 ML Operating Storage: 0 (operated empty) Area: ~2.9 ha	Captures water from Waste Rock Stockpile 1 and dewaters to Dam 1 to maintain empty. If exceeded, would overflow to Tooloombah Creek, after settling within the dam.
Environmental Dam 1C	Mine affected water dam Full Supply Storage: 44.1 ML Operating Storage: 0 (operated empty) Area: ~2.7 ha	Captures water from MIA / CHPP 1, and dewaters to Dam 1 to maintain empty. Constructed with additional storage capacity to contain flows, but if exceeded would overflow to Dam 1, after settling within the dam.
Environmental Dam 2D1/2	Sediment dams Full Supply Storage: 26.9 ML Operating Storage: 0 (operated empty) Area: ~1.4 ha + ~0.5 ha	Captures runoff from part of the haul road, and dewaters to Dam 1 to maintain empty. If capacity is exceeded, would overflow to Deep Creek, after settling within the dam.

Infrastructure	Details	Management / Operating Rules
Dam 4	Mine affected water dam Full Supply Storage: 95.8 ML Operating Storage: 0 (operated empty) Area: ~6.8 ha	Captures water from the train loadout facility, rail loop and part of the haul road and dewaters to Dam 1 to maintain empty. The product coal stockpile means this dam may be considered mine affected water. The dam could overflow to a tributary to Deep Creek, but will be managed to prioritise transfer of this water to Dam 1 as required to avoid overflows.
Levee	Flood protection, contaminated water containment Length: 2.3 km extending from Dam 1 wall Crest Elevation: above 0.1% AEP level	The levee is proposed to extend from the western end of the Dam 1 wall. Combined with the Dam 1 wall, elevated MIA / CHPP 2 platform and access road, this provides flood protection from the Bruce Highway on the west around to the highway on the east, for the Project elements on the north side of the highway.
Diversions		
Northern Catchment Diversion Drain	Located on the northern side of the Bruce Highway Length: 3.5 km	Temporary drain which will be in place for approximately the first half of the Project life before being mined through
Southern Catchment Diversion Drain	Located south of Open Cut 1 Length: 1.3 km	Constructed in the latter half of the Project life to divert catchment runoff away from the open cut pit to Deep Creek
Other		
Fuels, oils Chemical storage	Chemical, fuel and temporary liquid waste storage facilities will be constructed and bunded in accordance with the relevant specifications of *AS1940 - Storage and Handling of Flammable and Combustible Liquids* (AS1940). Fuel storage areas associated with Project operations will be inspected regularly, with repair and maintenance work completed as required. Bunds filled with stormwater will be drained or pumped out by a licensed contractor as soon as practicable to maintain the bund volume. Runoff from the vehicle wash down and workshop areas will be treated by an oil and grease separator prior to collection in the mine water management system for re-use. Waste oil, grease, etc. will be stored in contained areas prior to removal off-site.	

9.4.5 Controlled Release Rules

In order to minimise the risk of uncontrolled releases from overtopping storages during wet climatic conditions, controlled release from Dam 1 to Deep Creek release point (RP1) will be required. Receiving water flow rates will be measured at the Deep Creek gauging station, and releases made according to the receiving water flows and release characteristics as shown in Table 9-12.

Table 9-12: Proposed controlled release rules

Deep Creek Flow Condition	Receiving Water Flow Criteria for Discharge (m^3/s)	Maximum Release Rate (m^3/s)	Release limit	
			EC (µs/cm)	Sulfate (SO_4^{2-}) (mg/L)
Low Flow	0.1	0.018	1,000	38
Medium Flow	4	0.142	2,000	80
High Flow	50	1.09	3,000	120
Very High Flow	100	2.02	4,000	160
Flood Flow	250	3.07	8,000	330

9.4.6 Release Criteria and Site Specific Trigger Values

The Surface Water Quality Technical Report in Appendix A5a provided an assessment of the existing baseline water quality, including generating statistics summarising relative parameter concentrations at the different sites and systems in the Project area. The assessment also provided release criteria for parameters in addition to those described in Section 9.4.5, and developed SSTVs for receiving waters to trigger action or further investigation.

Proposed release criteria are provided in Table 9-13 and Table 9-14, with SSTVs for receiving waters summarised in Table 9-15.

Table 9-13. Proposed water release criteria

Parameter	Trigger Level
Flow (ML/d)	As per the controlled release rules in Table 9-12
EC (µS/cm)	
Sulfate (mg/L)	
pH (pH units)	6.5 – 9.0[1]
Turbidity	50[2]

Table notes:
1 From DES (2013) Model Water Conditions for Coal Mines in the Fitzroy Basin
2 Based on achievable release limits from sediment basins for suspended solids (Appendix 2, Table A Construction phase – stormwater management design objectives, Queensland State Planning Policy July 2017) and adopted SSTV for turbidity in receiving waters (from the EPP (Water) DGV)

Table 9-14: Release contaminant trigger investigation levels

Parameter	Trigger Level (mg/L)	
	Deep Creek	Tooloombah Creek
Aluminium (dissolved)	0.24	0.055
Arsenic (dissolved)	0.013	

Parameter	Trigger Level (mg/L)	
	Deep Creek	Tooloombah Creek
Boron (dissolved)	0.37	
Cadmium (dissolved)	0.0002	
Chromium (dissolved)	0.001	
Cobalt (dissolved)	0.090	
Copper (dissolved)	0.003	0.002
Iron (dissolved)	0.3	
Lead (dissolved)	0.004	
Manganese (dissolved)	1.9	
Mercury (dissolved)	0.0002	
Molybdenum (dissolved)	0.034	
Nickel (dissolved)	0.011	
Selenium (dissolved)	0.010	
Silver (dissolved)	0.001	
Uranium (dissolved)	0.001	
Vanadium (dissolved)	0.010	
Zinc (dissolved)	0.008	
Ammonia – as N	0.900	
Nitrate – as N	1.100	
Petroleum Hydrocarbons (C6-C9)	0.020	
Petroleum Hydrocarbons (C10-C36)	0.100	
Fluoride (total)	2.0	

Table notes:
List of parameters from the DES (2013) Model Water Conditions for Coal Mines in the Fitzroy Basin

Table 9-15. Summary of adopted receiving water SSTVs

Parameter	Deep Creek	Tooloombah Creek	Deep and Tooloombah Creek Confluence (St1)	Styx River at Ogmore Bridge (St2)
pH	6.5 - 8.3			
Dissolved Oxygen (%Sat)	65 – 110			
EC (µS/cm)	740	1,640	-	-
Sulfate (mg/L)	25	54	-	-
Total Suspended Solids (mg/L)	26	11	15	30
Turbidity (NTU)	50			
Ammonia – as N (mg/L)	0.088	0.055	0.060	0.130
Oxidised Nitrogen – as N (mg/L)	0.023	0.014	0.020	0.028
Total Nitrogen – as N (mg/L)	2.48	0.69	0.60	0.74
Filterable Reactive Phosphorous – as P (mg/L)	<0.010			
Total Phosphorous – as P (mg/L)	0.484	0.065	0.090	0.180
Dissolved metals and metalloids	Compare against SSTVs in the Surface Water Quality Technical Report (Appendix A5a)			

9.4.7 Regulated Structures Assessment

All proposed storages and levees have undergone a preliminarily consequence category assessment against the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures (*ESR/2016/1933 Version 5.01) (DES 2016) to determine the minimum hydraulic performance requirements. The assessment is provided in the Preliminary Dams Consequence Category Assessment in Appendix A5e.

The assessment considered each of the following failure event scenarios:

- 'Failure to contain – seepage' – spills or releases to ground and/or groundwater via seepage from the floor and/or sides of the structure.
- 'Failure to contain – overtopping' – spills or releases from the structure that result from loss of containment due to overtopping of the structure.
- 'Dam break' – collapse of the structure due to any possible cause.

A summary of the consequence assessment outcomes is shown in Table 9-16. Dam 1 was classified under the 'High' consequence category for the dam break scenario and 'Significant for the failure to contain scenario, and so is classified as 'High' and is a regulated structure. Environmental Dams 1B and 1C, Dam 4 and the levee were classified under the 'Significant' consequence category for the 'failure to contain' and dam break' scenarios. Levees were determined to be regulated structures and hence must have a crest elevation higher than the peak 0.1% AEP flood level.

The 'failure to contain – seepage' scenario has a minimum classification of 'significant' in the consequence manual. Leak detection and monitoring may be imposed through EA conditions for regulated dams containing contaminants, such as the MIA dams, Dam 4 at the TLF, and Dam 1 receiving the pit dewatering.

Table 9-16: Consequence assessment summary

Storage	Scenario	Consequence Category[1]	Overall Consequence Category	Comments
Dam 1	Failure to Contain - Seepage	Significant (GEH)	High Regulated Structure	The dam will contain a large quantity of water with elevated salinity that could result in material environmental harm to the receiving environment in the event of a seepage or overtopping failure to contain event. Dam break failure of the dam would likely result in very significant environmental harm and considerable third party property damage and economic loss. Harm to humans from a dam break failure of the dam is considered unlikely to occur but would need to be confirmed with a dam break assessment.
	Failure to Contain - Overtopping	Significant (GEH)		
	Dam Break	High (GEH)		
Environmental Dam 1B	Failure to Contain - Seepage	Low	Significant Regulated Structure	Overtopping or dam break failure of the dam may result in material environmental harm to the receiving environment.
	Failure to Contain - Overtopping	Significant (GEH)		

Storage	Scenario	Consequence Category[1]	Overall Consequence Category	Comments
	Dam Break	Significant (GEH)		Seepage impacts are expected to be relatively minor as a result of the small footprint and low height of the dam and the dilution capacity of the receiving groundwater system.
Environmental Dam 1C	Failure to Contain - Seepage	Low	Significant Regulated Structure	Env. Dam 1C will receive runoff from the CHPP and MIA area which is likely to have elevated concentration of coal fines, hydrocarbons and metals. Overtopping or dam break failure of the dam may result in material environmental harm to the receiving environment. Seepage impacts are expected to be relatively minor as a result of the small footprint and low height of the dam and the dilution capacity of the receiving groundwater system.
	Failure to Contain - Overtopping	Significant (GEH)		
	Dam Break	Significant (GEH)		
Environmental Dam 2D1	Failure to Contain - Seepage	Low	Low Not a regulated structure	The dam will have a small storage capacity and is not expected to contain water of high toxicity (haul road runoff). The consequences of seepage, overtopping or dam break failures are considered likely to be relatively minor.
	Failure to Contain - Overtopping	Low		
	Dam Break	Low		
Environmental Dam 2D2	Failure to Contain - Seepage	Low	Low Not a regulated structure	The dam will have a small storage capacity and is not expected to contain water of high toxicity (haul road runoff). The consequences of seepage, overtopping or dam break failures are considered likely to be relatively minor.
	Failure to Contain - Overtopping	Low		
	Dam Break	Low		
Dam 4	Failure to Contain - Seepage	Low	Significant Regulated Structure	Dam 4 will receive runoff from the haul road and Rail Loadout which is likely to have elevated concentration of coal fines, hydrocarbons and metals. Overtopping or dam break failure of the dam may result in material environmental harm to the receiving environment. Seepage impacts are expected to be relatively minor as a result of the small footprint and low height of the dam and the dilution capacity of the receiving groundwater system.
	Failure to Contain - Overtopping	Significant (GEH)		
	Dam Break	Significant (GEH)		
Levee	All	Significant (HH)	Significant Regulated Structure	Failure of the flood protection levee under flooding conditions will result in the inflow of large volumes of clean water into Dam 1 and Open Cut 2 which would likely overwhelm the mine water containment system, impact the mining operations and potentially

Storage	Scenario	Consequence Category[1]	Overall Consequence Category	Comments
				cause Dam 1 to fail and release its contents into the downstream receiving environment.

Table notes:
1. GEH – General Environmental Harm category; HH – Harm to Humans category

Only dams with an embankment height of greater than 10 m may be categorised as 'referrable', thus requiring a Failure Impact Assessment (FIA). Dam 1 could possibly fall within this category, pending the outcomes of further assessment and final detailed design. The dam FIA, if required, will be undertaken as outlined in the 'Guidelines for Failure Impact Assessment of Water Dams' (DNRME 2018). The population at risk (PAR) determined by the FIA will inform the failure impact category that applies to the dam and subsequently the minimum design requirements outlined in applicable Australian National Committee on Large Dams guidelines. The chief executive will then impose dam safety conditions, which are likely to include the following:

- the provision of design and construction reports
- the preparation of an Emergency Response Plan as prescribed by the Department of Energy and Water Supply (DEWS) guideline for referable dams
- the production of Operation and Maintenance Manual procedures in accordance with DNRME guidelines and
- development of standard operating procedures.

It is not anticipated that any of the dams conceptualised herein will create a PAR due to the sparse population density.

9.5 Potential Impacts of the Project

The general potential impacts to surface water systems as a result of the Project can be summarised as follows:

- Point source discharges to waterways – from intentional dam releases, unintentional dam overflow / releases, localised erosion and sedimentation, and spills and leaks, including from waste rock storages or groundwater affected by mining operations (such as from waste rock or in-pit storage).
- Area sources – altered loads from larger catchment areas as a result of land use change, including increases in erosion and sedimentation of waterways, broad based leakage from groundwater and waste rock storages.
- Changes to flow patterns from concentration of flows due to constrictions in flow passages, alterations of floodplain areas, and the like, resulting in changes to erosion, sedimentation and bed load.

These can occur during both construction and operational activities, and are discussed below by the type of impacting activity, namely:

- construction
- vegetation clearing and

- changes to site hydrology.

Impacts to fish passage are discussed in Chapter 15 – Aquatic and Marine Ecology.

9.5.1 Construction

During the construction phase of the Project, the primary potential pollutant will be elevated sediment in runoff, due to vegetation clearing and disturbance of soils, ultimately discharging mainly to Deep Creek but with some areas currently draining to Tooloombah Creek. Other pollutants that could potentially be released from construction works include from concreting, painting and fuels and oils from refuelling operations, leaks and/or spills.

Initial construction will involve the clearing of approximately 350 ha for infrastructure, utilities, haul and access roads, train loadout facility and rail loop, and water infrastructure north of the Bruce Highway, which will increase progressively as operations commence and throughout the life of the mine.

9.5.2 Vegetation Clearing

Clearing of vegetation will occur in the construction phase and throughout the operational phase as the active pit progresses.

9.5.3 Changes to site hydrology

Construction of haul roads, dams and particularly catchment diversion drains will affect the existing hydrology by changing local catchment locations and sizes, discharge points and the way water moves around the site. Additional hardstand areas can increase runoff velocities, as can steeper slopes, leading to enhanced erosion and sediment loss, as well as loss of other constituents in contact with the eroding water.

Steeper slopes will form on out of pit waste rock stockpile areas, and could form in the catchment diversion drains and other minor diversion and catch drains on the site, without adequate design. Concentrated flows have the potential to scour drainage systems and creeks where they enter, such as for the catchment drainage diversions.

Alteration of floodplain morphology may cause a change in bed shear stress, velocity and water depth, which in turn could alter sediment transport, and bed and bank erosion processes within local waterways.

Alterations to local catchments could also impact the amount of water flow in local creeks and the water balance of surface wetland features due to reductions in catchment areas.

Watercourse and creek crossing structures may cause a localised increase in runoff velocity due to the construction of culverts and conveyance features that eliminate natural waterway features such as meanders, and increase slope and flow velocity. However, with appropriately designed stormwater and crossing structures, such processes are unlikely to cause more than localised and very minor changes to surface hydrology.

Changes to site hydrology also affect how flood waters interact on and off the site, potentially impacting properties and systems external to the site. The following elements are likely to impact flood behaviour:

- haul road crossing of Deep Creek

- construction of Dam 1, capturing runoff from overbank areas between Tooloombah and Deep Creeks and
- the two catchment diversion drains (north and south of the Bruce Highway, upslope of each open cut pit).

9.5.4 Waste Rock and Coal Rejects

Waste rock and coal rejects have the potential to provide pollutants to downstream waterways, through erosion and leaching of contaminants. Geochemical characterisation presented in Appendix A3b (and Chapter 8 – Waste Rock and Rejects) concluded that the overwhelming majority of the waste rock and potential coal reject materials have a very low risk of acid generation, and runoff from waste rock and coal rejects would be alkaline and have a low level of salinity. Dissolved metal/metalloid concentrations are expected to be low and unlikely to pose a significant risk to the quality of surface and groundwater resources in site storages. However, the waste rock has potential to be highly sodic, which have potential to cause slaking, are dispersive, and tend to be highly erodible.

As such, the greatest risk from waste rock, considering that coal rejects will be encapsulated within stockpile areas, will be sediment, which could be enhanced should highly sodic materials be emplaced on the outside of stockpile areas, or subject to prolonged water flow (i.e. through high levels of infiltration).

9.5.5 Site Drainage and Accidental Releases

Runoff from various parts of the site, including coal stockpiles, MIA, earthworks associated with maintenance of roads and dams, drainage structures and other site features may be contaminated or become contaminated. Mine affected water is retained in on-site storages with their releases addressed in Section 9.5.6. Other drainage features may discharge directly off-site, where containing only elevated sediments, and will be managed under the ESCP (a draft plan is included in Appendix A15a).

Accidental release of pollutants, such as through spills and leaks, may adversely impact Deep Creek as the Project majority lies within the Deep Creek catchment. There is a less likely impact on Tooloombah Creek as Dam 1 is the only infrastructure to potentially discharge into the creek, and these are managed under water releases described in Section 9.5.6.

Potential sources of pollutants include MIA and the CHPP areas, which are located approximately 230 m (MIA / CHPP 2) and 2.4 km (MIA / CHPP 1) from Deep Creek.

Releases from waste rock stockpiles and coal rejects are discussed in Section 9.5.4.

Without mitigation, potential exists for aqueous waste streams to potentially enter waterways. This includes such things as:

- oily waste water (from heavy equipment cleaning)
- contaminated runoff from chemical storage areas
- contaminated drainage from fuel oil storage areas and
- general washdown water.

9.5.6 Dam Water Releases

Water quality within the dams may be affected by the source of the water, including mine affected water from coal processing and storage areas, MIA, waste rock stockpiles, haul roads and sediment basins. Storage of water in dams, particularly where this is sourced from more saline groundwater, can also result over time in increases in salinity, and potentially other contaminants as the waters become more concentrated due to evaporation, particularly where the water is retained within the site water circuit undergoing further concentration with each pass (such as in the CHPPs).

Controlled water releases are proposed for Dam 1 as part of the Project during operations, and uncontrolled releases may occur due to wet periods resulting in releases to both Deep and Tooloombah Creeks. Constituents within the dam waters may impact on the water quality and aquatic ecology of receiving waters. Release locations are shown in Figure 9-36.

Leaks and spills may also cause accidental contamination of waters should they be released to the environment.

Increased sediment loads from coastal catchments is also a key threatening process for the GBR (GBRMPA 2019). However, changes in land use at the Project Area, from the current situation of grazing to a mixture of mining and environmental offsets, is predicted to result in an overall reduction in sediment discharges to waterways through improved land management practices, despite the potential for discharge of sediment-laden water from mine dams (Appendix A15b).

9.5.7 Direct Disturbance of Waterways

The Project MIA, open cut pit and stockpiles are unlikely to directly disturb the watercourses. However, the abovementioned Project components and infrastructure will cut-off the two drainage features that traverse the open pit locations. This will result in lower flows in the reaches downstream of the open pits.

Most of the waterway disturbance will occur at the haul road crossings of Deep Creek, Barrack Creek and an unnamed tributary of Deep Creek. Both Deep Creek and Barrack Creek are incised with channel depths in the range of 6.5 m to 7.8 m. The unnamed tributary of Deep Creek is significantly shallower with a channel depth of around 3.5 m.

At these crossings, impacts may include riparian vegetation clearing, direct deformation of the bed and banks, and alteration of hydrological flows. Consequential impacts may include decreased habitat, increased potential for erosion and an increase in runoff velocity due to effective increase in bed slope that can result from the construction of cross-drainage structures.

9.5.8 Groundwater drawdown

Beyond the immediate effects of groundwater drawdown on groundwater systems, given the potential linkages between surface and groundwaters, particularly in Tooloombah Creek, there is the potential to impact on both baseflow duration and quantity and persistence of pools, resulting potentially in longer periods over which Deep and/or Tooloombah Creek are dry. Changes to groundwater may also change water quality in pools where saline groundwater inflows slow or cease, lowering the overall salinity within these pools, or impact riparian vegetation that may depend on groundwater, affecting the stability of banks.

9.5.9 Post-mining impacts

During the final six years of the Project life (Years 19 to 24), no mining will be undertaken, however some reworking of out of pit waste rock stockpiles will occur, and spreading and seeding of topsoil, along with application of water and plant fertiliser where required. Given the reduction in water flows from the site, this is anticipated to be of a much lower level of impact in terms of water quality (and quantity), and to progressively improve as rehabilitation works are completed.

Site hydrology will improve (reduced opportunity for high velocity, concentrated and erosive flows) compared to the operational phase, as site slopes are reduced to support grazing land uses, and surfaces are stabilised. Reinstatement of on site drainage features will be required to allow water to flow around the northern elevated landforms remaining, although both landforms remain outside of the main channel flood extent of both Tooloombah and Deep Creeks for the 0.1% AEP event.

9.5.10 Receiving Environment Impacts

The release of pollutants (accidental or via controlled releases) can result in adverse impacts on flora and fauna through chronic (long term) or acute (short term toxicity) effects, via slow and long term release of contaminants. Releases of sediments can smother and/or change aquatic habitat, cloud waters inhibiting growth of aquatic organisms, and is particularly important to the management of sediment loads entering the GBR lagoon.

The EVs for the receiving waters include irrigation, stock watering and human consumption. Accidental release of pollutants and contaminants may adversely impact downstream agricultural operations and prevent use of the water for human consumption.

Potential impacts of accidental pollutant and contaminant releases, if not adequately mitigated, could produce moderate impacts on local and downstream water quality, aquatic ecology, irrigation, farm supply, stock water and cultural / spiritual EVs. It is unlikely to impact human consumer and drinking water EVs due to the distance between the Project area and downstream extraction points.

9.6 Impact Assessment

9.6.1 Flooding

9.6.1.1 Project impacts

The pre-mining flood model was updated to match the Project layout to reflect mine site conditions and the removal of areas covered by pits and catchment diversions. The early phase (up to Year 10, north side of the Bruce Highway only) involved the following key elements:

- The construction of the northern catchment diversion drain to direct flow away from the Open Pit 2 and into Deep creek and a levee to prevent any flow entering the pit.
- The installation of a haul road and three sets of culverts consisting of five 3600x3600 RCBC culverts.
- Dam 1 assumed full in events of magnitude 1% AEP and greater and any overflow is discharged to Tooloombah Creek. Events smaller than 1% AEP are assumed to be retained in Dam 1 and there is no discharge from the dam to Tooloombah Creek for these events.

The modelled flood depth for the 1% AEP event is shown in Figure 9-38, with the afflux (difference between existing and developed) depths shown in Figure 9-39. The 0.1% AEP event for the early phase development is shown in Figure 9-40 showing that the Project is flood immune for this level of event. Mapping for other events are shown in the Flood Study and Site Water Balance Technical Report in Appendix A5b.

Modelling was also conducted for the 1% AEP event for the late phase development (Year 11 onwards, represented by Year 17, Figure 9-41). Comparison of the two found the most significant potential impacts of the Project on flooding to be associated with the early phase of mine development with the northern catchment diversion drain in place. Other flood events were therefore not required to be modelled for the late phase development.

The assessment found that increases in flood levels are small and generally minor and flooding is mostly confined within the banks of Tooloombah and Deep creeks (as in the existing case). Small increases of up to about 0.20 m are caused by the proposed haul road crossing, the diversion of local catchment runoff by the northern catchment diversion drain, and overflows from Dam 1.

The Bruce Highway retains its flood immunity in events up to 1% AEP with no significant impact along the road corridor from the Northern Drain. No significant increases in creek flow velocity due to the Project were found, with therefore minimal impacts on flow velocity in the creeks.

9.6.1.2 Climate Change Sensitivity

The flood model was run to assess flood impacts arising from the RCP8.5 climate change scenario (worst case), which results in the overtopping of the Bruce Highway in both developed and existing scenarios. There are no additional impacts on the mining lease area. Furthermore, given the climate change projections are for the year 2100, the chances of this situation arising during the life of the Project (to 2038 for mining, 2044 for rehabilitation) are considered low.

The results for the climate change sensitivity scenario can be found in Appendix A of the Flood Study and Site Water Balance Technical Report (Appendix A5b).

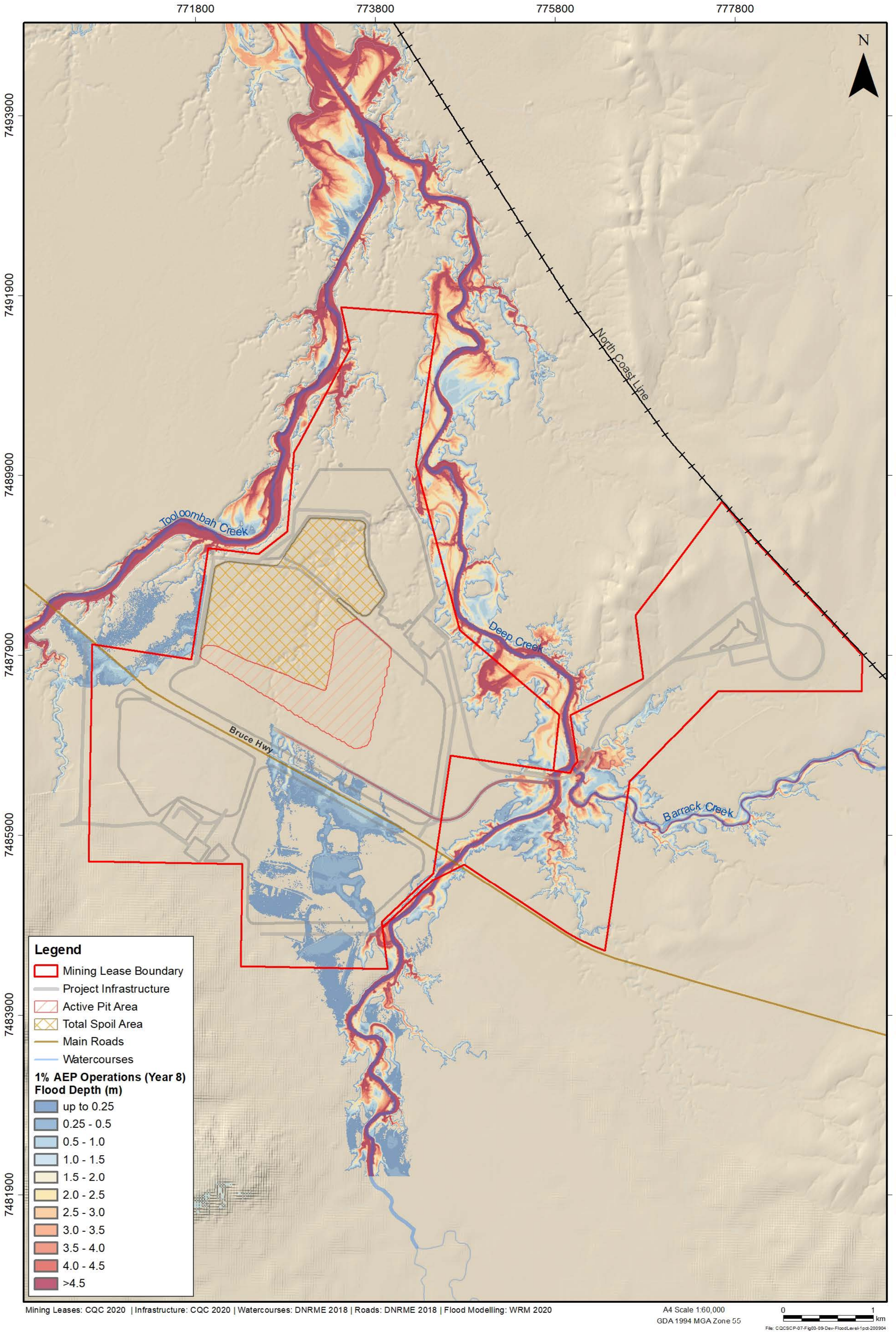

Figure 9-38: 1% AEP Early phase development, peak flood depth

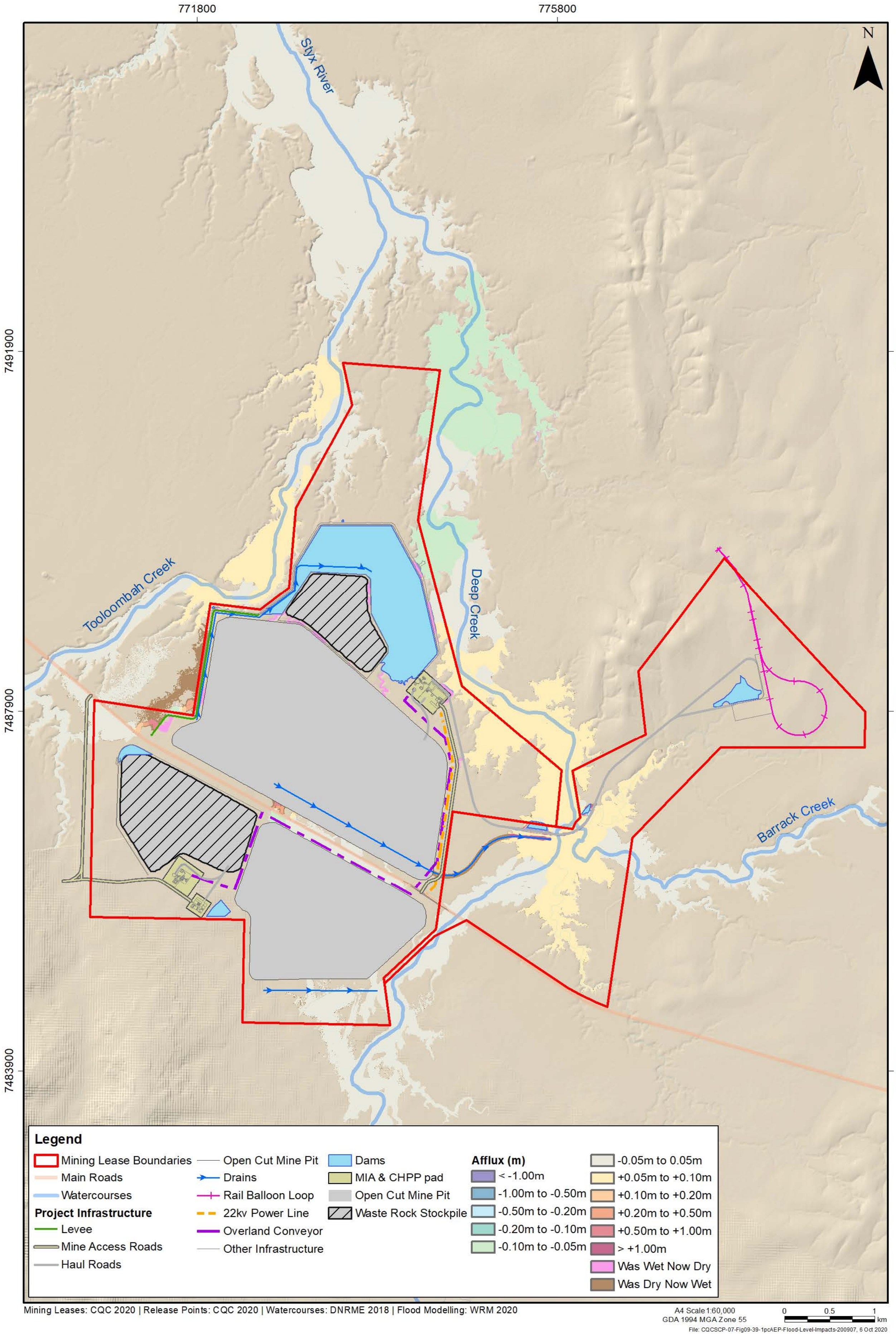

Figure 9-39: 1% AEP flood level impacts, early phase development

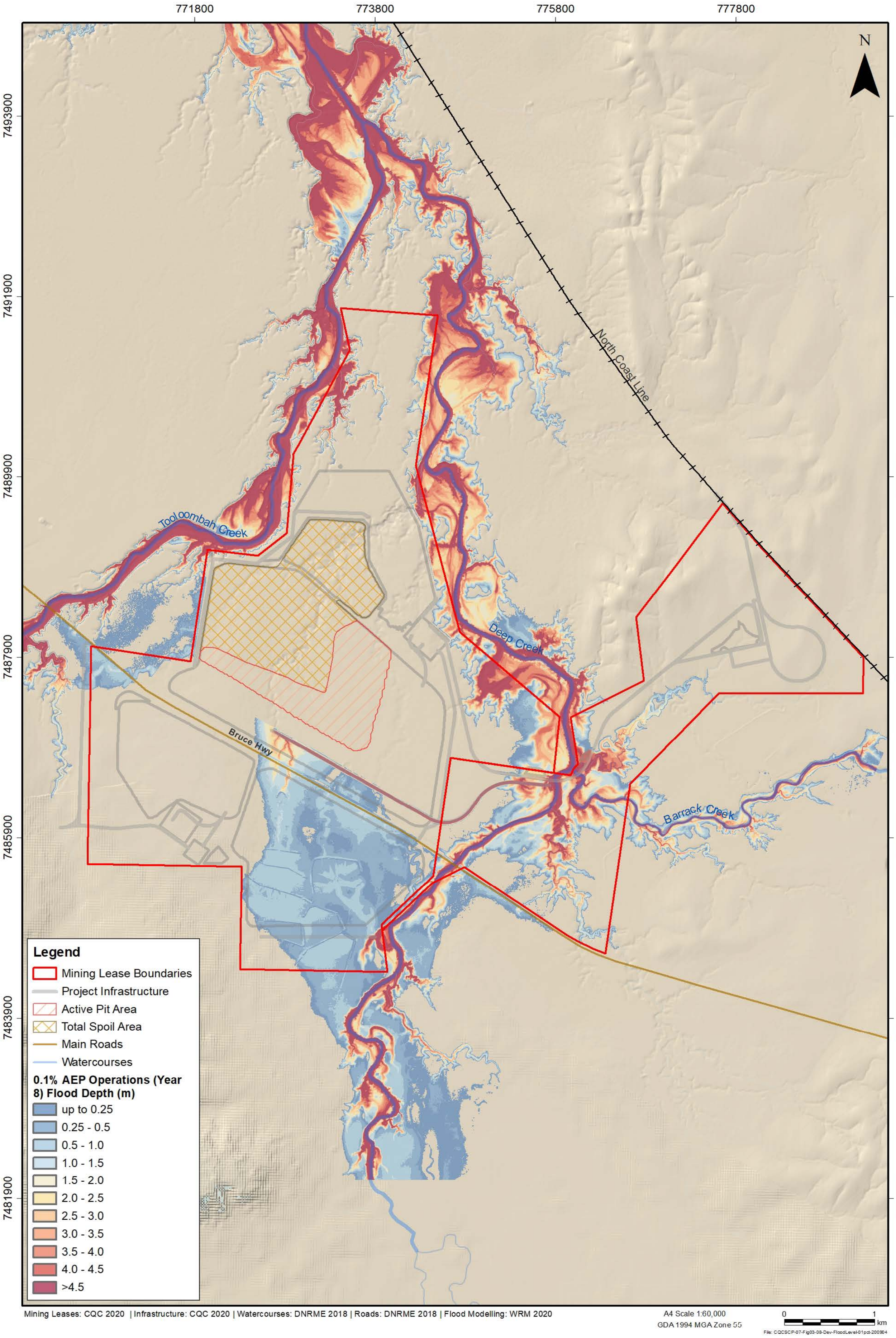

Figure 9-40: 0.1% AEP early phase development, peak flood depth

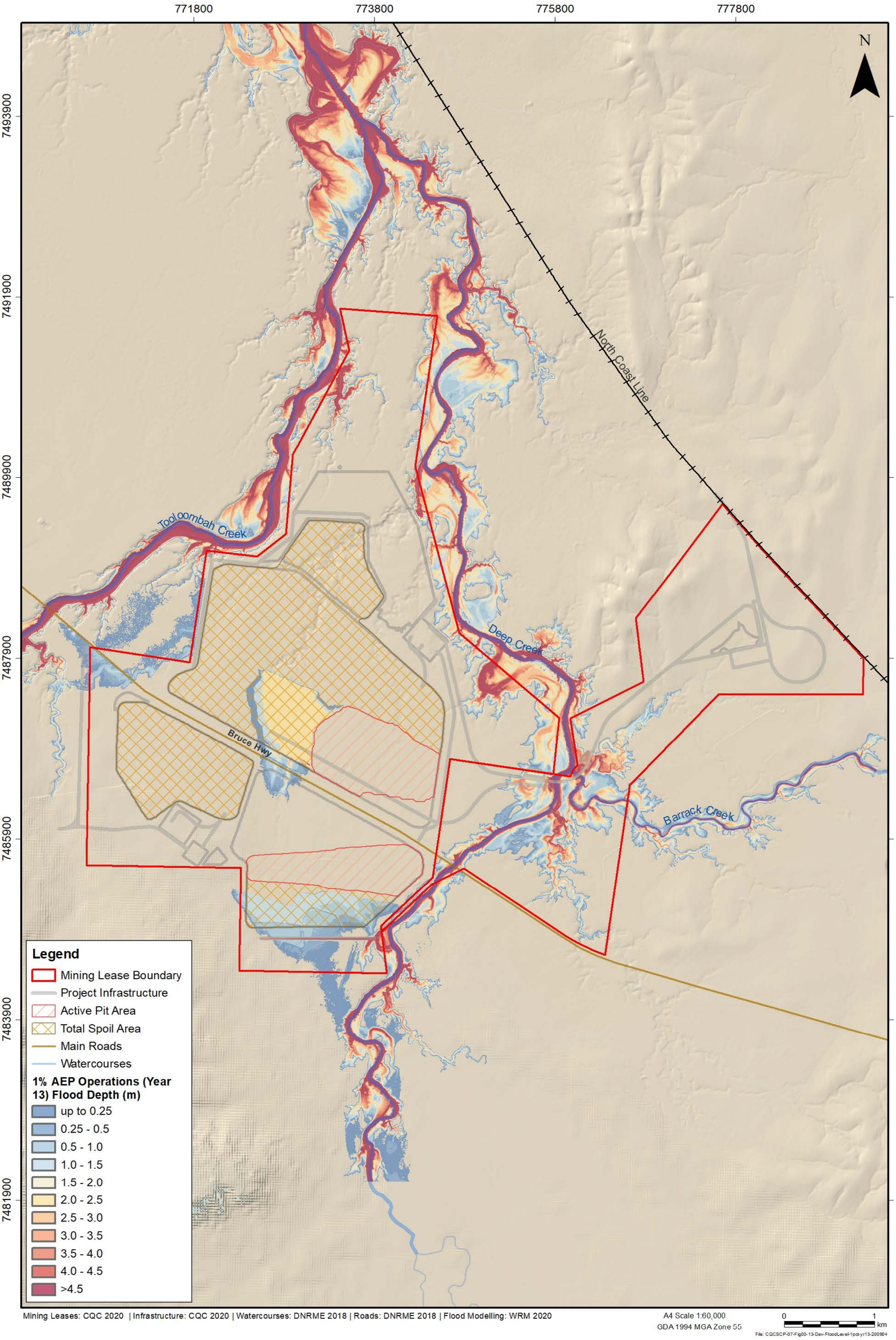

Figure 9-41: 1% AEP late phase development, peak flood depth

9.6.1.3 Post Mining Impacts

The proposed final landform is based on generally reinstating pre-mine surface levels across the backfilled open cut pits. Excess overburden material will be rehabilitated in two emplacements, one on either side of the Bruce Highway, graded to a maximum 12% slope and to support a post-mining low intensity grazing land use. These overburden emplacements are located outside the main channel flood extent of Tooloombah and Deep creeks, and are shown over the existing 0.1% AEP flood extent in Figure 9-42.

To mitigate flooding, the backfilled mining pit will include realigned drainage paths to drain local runoff, as well as any flow breakouts from Deep Creek, to Tooloombah and Deep creeks, as described in Chapter 11 - Rehabilitation and Decommissioning.

9.6.2 Streamflow and Pools

9.6.2.1 Changes to flow characteristics

During mining operations, the mine water management system will capture runoff from areas that would normally have flowed to creek systems and wetlands[11]. WRM Water and Environment prepared an assessment of changes to streamflow as a result of the Project, based on catchment excision – i.e. reduction in flows due to a reduction in catchment size and shown in Appendix A5b.

The largest catchment area reduction for the maximum development footprint occurs in Deep Creek with a catchment loss of 14.9 km^2, representing 4% of the total Deep Creek catchment. Assuming zero releases from Dam 1, Figure 9-43 shows the flow-duration relationship for the existing and reduced catchments in Deep Creek. As can be seen, the impact is negligible, with the actual impact being less than shown due to the effect of wet weather releases from the water management system. As such, there will be no impact on the number of days that flow occurs in receiving watercourses.

Reduction in flow due to a reduction of groundwater inflows was not assessed in the above modelling, as flows only occur in the creeks for a very short duration (1 – 3 days), and these inputs appear to be important for maintenance of pools rather than of flow, which is primarily storm or return bank flow induced (refer to Section 9.3.4.5).

Changes to the location and quantity of inflows to the creeks will change – to a relatively minor amount in Tooloombah Creek, other than spillway discharges from Dam 1, and to a greater extent in Deep Creek, primarily due to the construction of the two catchment diversion drains bringing concentrated flows into Deep Creek at two locations (though not at the same time), and the haul road crossing structure.

Impacts have been found to be minor in terms of flooding (refer Section 9.6.1) and bed shear and velocity changes in the creek are discussed in Section 9.6.4.

[11] An assessment of wetlands is provided in Chapter 15 – Aquatic and Marine Ecology.

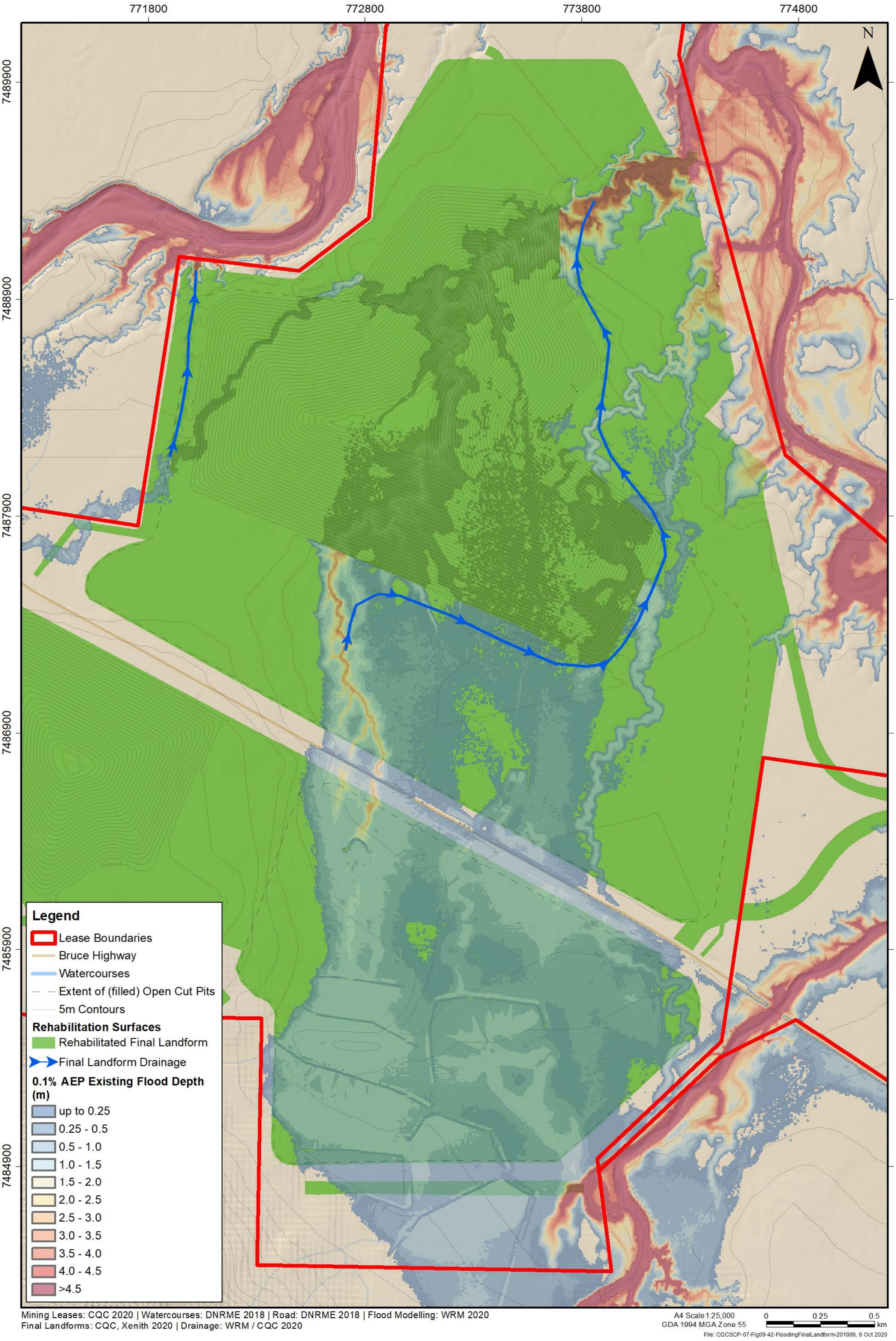

Figure 9-42: 0.1% AEP existing conditions flood extent with final landform

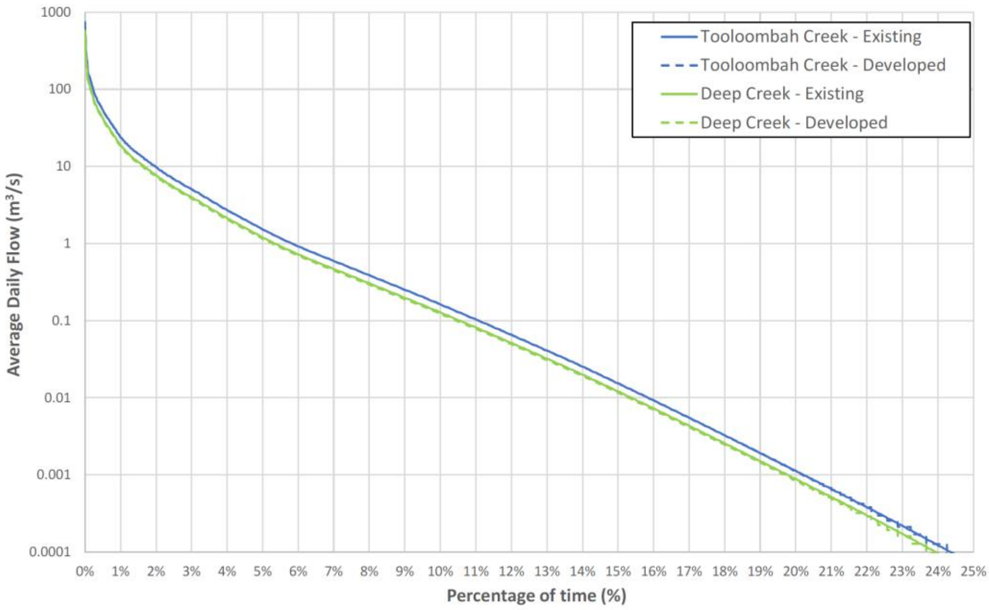

Figure 9-43: Impact of Project on receiving water flows

9.6.2.2 Changes to Pool Persistence

As discussed in Section 9.3.4.5, some of the pools within Tooloombah Creek, and possibly in the lower reaches of Deep Creek, are potentially supported by groundwater that may be reduced due to Project related groundwater drawdown. To investigate this, an impact assessment of the Tooloombah Creek pool associated with the streamflow gauging site was undertaken, as detailed in the Flood Study and Site Water Balance Technical Report in Appendix A5b. The assessment conducted in Appendix A5b found that a groundwater inflow of 4.5 kL/day with EC of 15,000 µS/cm matched the existing level and EC found in the pool. Groundwater inflow was reduced in two further simulations – one to a groundwater inflow of 0 kL/day, the second to a groundwater outflow of 9 kL/day.

The Numerical Groundwater Model and Groundwater Assessment Report (Appendix A6b) predicted a reduction in baseflow of 0.009 m^3/s over a reach of 9.3 km, or approximately 1 L/s per km. Given the pool length of approximately 140m, the groundwater model predicted reduction would be in the order of 12 kL/day, which is incorporated into the simulated range of reduction (reduction of up to 13.5 kL/day).

The model was run for the 131 year period of historical rainfall (1889 – 2019), using the AWBM rainfall-runoff model to simulate filling through runoff, and an overflow level of 10 mAHD, matching the cease to flow level of the gauge. The assessment found the following:

- under existing conditions (groundwater inflow 4.5 kL/day), the pool is perennial, containing water for 100% of the simulation
- with zero groundwater inflow, the pool would be almost perennial, containing water about 96% of the time, only drying out during major drought conditions and
- with a groundwater outflow of 9 kL/day, the pool was found to dry out about 30% of the time.

Salinity results show that a reduction in groundwater baseflow would reduce salinity. Under existing conditions, median pool EC is about 3,500 µS/cm. This would drop to between 200 to 300 µS/cm for the other two scenarios.

Additional and similar modelling work undertaken by ELA (refer to the Surface Water / Groundwater Interactions Report in Appendix A6d) on a number of other pools identified site To2 upstream of the above Tooloombah Creek gauging site as being potentially fed by an external water source. However, the assessment looked in more detail at the mechanisms of baseflow and interflow to the creek through the installation of and sampling from drillholes in sections through (or up to) the creek. They concluded that the increase in salinity observed within some surface water pools along Tooloombah Creek is likely driven by dissolved salts produced and collected through bank storage draining towards the creek. This may be supplied by seasonal rise in the underlying water tables (i.e. the Styx Coal Measures) periodically bringing more saline groundwater into the alluvium that persists in the alluvium aquifer in the vicinity of the pools even when the regional water table recedes.

They concluded that Tooloombah Creek is groundwater fed, but primarily from bank flow, in some locations, and this is evident particularly in the stretch adjacent to the Project site (refer Section 9.3.4.5). Deep Creek also feeds wet season and flood flows into bank storage, but due to differing geology, this is much lower in magnitude, and may not reach the creek in some areas. In particular, they conclude that pools are unlikely to be sustained during the dry season in this area of Deep Creek.

Therefore, direct drawdown impacts on the pools within both creeks are unlikely – i.e. it is not anticipated that water table aquifers supply the creeks in the dry season directly, since the water table is already below the base of the creeks and drawdown within the water table would not change this.

The primary mode of impact would therefore be the lowering of the water table in proximity to the Project in the wet season, by lowering the regional groundwater levels, and reducing the height that the water table reaches. This could have the effect of reducing the amount of water that is supplied by seasonal rise in the underlying water tables, and in effect some bank recharge flow may be lost to the water table aquifer rather than returned to the creek – this impact will be smaller in Tooloombah Creek, where an impermeable layer of clays exists between the Alluvium and the Styx Coal measures, than in Deep Creek. However, since the processes of bank flow storage and return are very local to each reach of the creeks, and that rainfall and surface water flow in the wet season (the primary recharge mechanisms) are not going to be affected by the project (refer to the Surface Water/Groundwater Interactions Report in Appendix A6d), the overall effect may be quite small.

Overall, based on the degree of permanence and the identification of bank flow water supply pools in some of the Tooloombah Creek pools, there could be impacts to pools to the west of Open Cut 2 in Tooloombah Creek, if local water table aquifers are lowered affecting wet season recharge of bank storage. Otherwise, there are not expected to be significant impacts to pools within the Project area.

9.6.2.3 Water Quality in Pools

In terms of water quality and as noted above, reductions in bank flow return would also lower salinity in some of the pools in Tooloombah Creek (since groundwater from the water table aquifer is typically more saline). The most substantial effects would then be in terms of the amount of time the system remains with water, which would not be expected to otherwise significantly affect water quality within the pools. Given the ephemeral nature of both Deep and Tooloombah Creeks, the overall water quality impacts are also expected to be negligible and to mirror existing processes in the system.

9.6.3 Site Water Balance

The water balance model used to develop the site water storage sizing and described in Section 9.2.5 was used to assess water supply reliability, water inventory and pit inundation, the frequency of overflows, and the anticipated water quality impacts of these releases. These are discussed in the following sections.

Importantly, the modelling was run for an 18 year period, corresponding to the Project mining life. The model was run for 114 climate sequences, each referred to as a realisation, and based on an 18 year sequence extracted from the historical data. The first realisation was based on 1889 to 1906, with the start year incremented for each new realisation (i.e. 1890 to 1907, etc.) to provide a wide range of potential climatic conditions.

The data therefore is provided as a probability distribution, where results relate to a percentage probability of exceedance. As an example, the 10^{th} percentile represents a 10% probability of exceedance, and the 90^{th} percentile represents a 90% probability of exceedance, with an 80% chance that the result will lie within the 10^{th} to 90^{th} percentile range. It does not relate to climate directly – for site water storage assessing overflow risk, smaller percentiles correspond to wet conditions, so that there is only a small chance that the 1 percentile release volume will be exceeded, generally corresponding to wet conditions. For water supply the 1 percentile relates to insufficient water being available, and so represents dry conditions.

Model setup, operating rules and water management system layout are described in Appendices A5b (Flood Study and Site Water Balance Technical Report) and A5c (Draft Water Management Plan), and summarised in Sections 9.2.5, 9.2.7 and 9.4.

9.6.3.1 Water Supply Reliability

The volume of water captured on site for reuse is highly dependent on climatic conditions and the volume of groundwater inflows, and modelling was undertaken to test the reliability of the water supply for the site. Figure 9-44 shows the projected water supply requirements under normal operations for the Project, showing that the site may experience a small water supply shortfall under some climatic conditions, specifically:

- for very dry conditions (1%ile results), the Project may experience a maximum demand shortfall of 650 ML/a
- for dry conditions (10%ile results), the Project may experience a maximum demand shortfall of 330 ML/a and
- for median climatic conditions (50%ile results), the Project may experience a maximum demand shortfall of 65 ML/a.

An adaptive management approach will be used to deal with dry conditions on site to ensure minimal interruptions to operations due to water supply limitations. Advanced dewatering within the open cut footprint could provide a potential source of water to meet shortfalls during dry conditions, particularly at the beginning of operations. Production changes such as reducing the production of ROM coal and/or the amount of water being used by exporting a high grade thermal coal product (i.e. not washing the coal, rather than producing a semi-soft coking coal product, which needs washing) can also be used.

During construction and the establishment of the external water supply, water will be required to be trucked in and stored onsite.

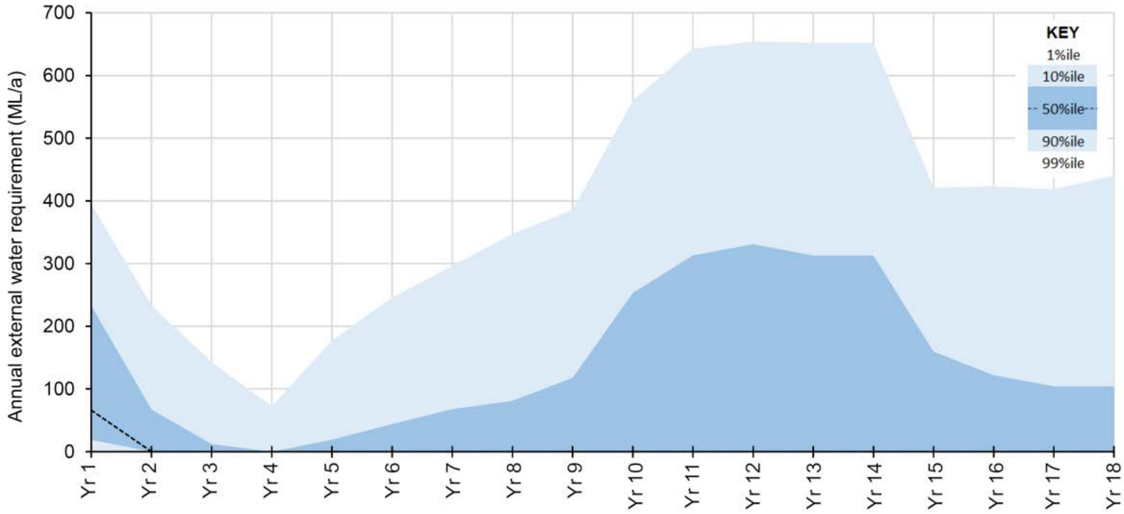

Figure 9-44: Forecast external water supply requirements

9.6.3.2 Site Water Inventory and Pit Inundation

An assessment of the site water inventory was conducted to test the ability of pits to be dewatered effectively over the life of the Project, and determine whether the Dam 1 storage is sufficient to contain the Projected inflows. Modelling for Dam 1 adopted a maximum operating volume (MOV) of 1,800 ML to reduce the risk of overflows - this is the volume at which pumping from the open cut pits and sediment dams to Dam 1 ceases.

The modelling results are shown in Figure 9-45, which identifies that, with the proposed operating rules and system configuration, the peak inventory in Dam 1 reached:

- around 2,710 ML for the 1%ile results (very wet conditions)
- 2,195 ML for the 10%ile results (wet conditions) and
- below 1,000 ML in the early years of the Project, rising towards the MOV at the end of Project life for the 50%ile results (median conditions).

While the results indicate that Dam 1 exceeds its operating volume, there is only a very small risk (under 1%) that the full supply volume of Dam 1 would be reached at some point over the life of the Project.

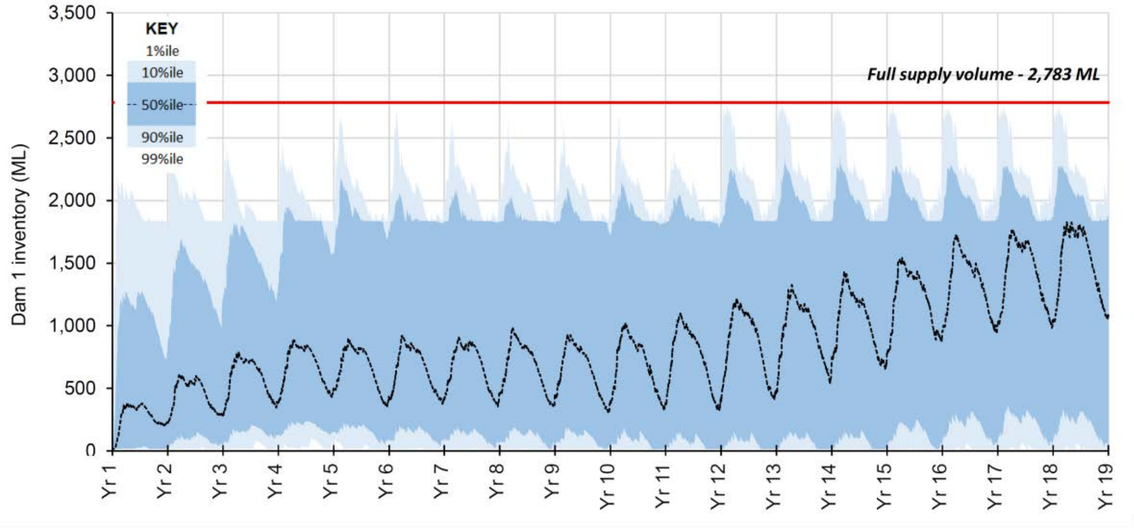

Figure 9-45: Forecast Dam 1 inventory

The modelling results for the mine pit inventory are shown in Figure 9-46 for Open Cut 1 and Figure 9-47 for Open Cut 2. As can be seen, Open Cut 1 appears to recover after each wet season. For the first 11 years of the Project, Open Cut 2 appears to recover after each wet season, however after Year 11, there is a risk that water will accumulate within Open Cut 2. Given that Open Cut 2 will be mined out by Year 14, this is unlikely to represent a high overall Project risk.

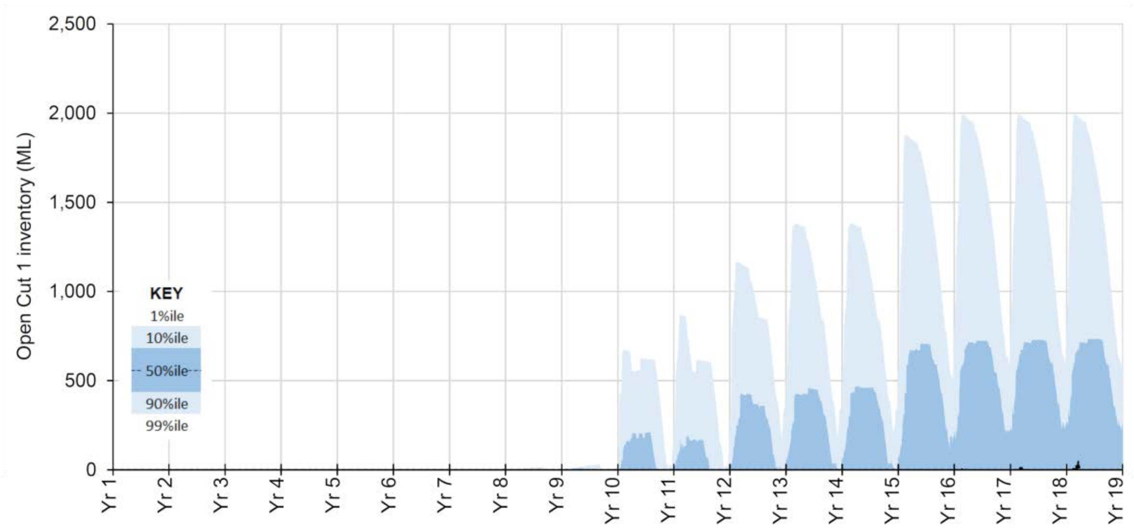

Figure 9-46: Forecast Open Cut 1 inventory

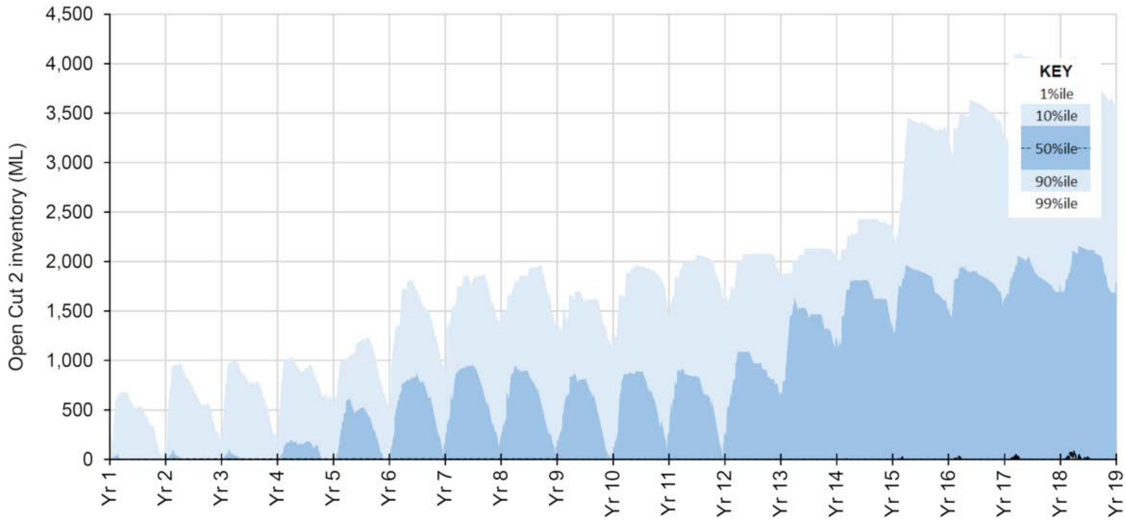

Figure 9-47: Forecast Open Cut 2 inventory

9.6.3.3 Release Volumes

Controlled releases occur from Dam 1 to Deep Creek, via a controlled release structure (refer to Section 9.4.3.2), based on the controlled release rules provided in Section 9.4.5. The results of the modelling are provided in Figure 9-48, showing that under median climatic conditions, predicted annual releases range up to 40 ML/a. Under wet conditions (10%ile), the volume increases to between 780 – 1,430 ML/a, and for very wet conditions (1%ile), between 2,790 – 2,930 ML/a.

Mine affected water dams that could potentially overflow directly to the receiving environment if inflows exceed the storage design criteria include Dam 1 (to Tooloombah Creek), and Dam 4 (to a tributary to Deep Creek). Dam 1 is managed to minimise uncontrolled releases by efficient site water usage and undertaking controlled releases, when conditions allow. Dam 4 dewaters to Dam 1, and is maintained empty until Dam 1 reaches its operating volume.

The predicted annual overflows from Dam 1 (Figure 9-49) show that there is only a very small (around 1%) risk of an overflow occurring in the first 10 years of the Project, with a maximum annual overflow volume of 320 ML/a. The annual risk increases from Years 11 to 18 to around 10%, due to the increase in upstream natural catchment draining to the dam. Under very wet conditions (1%ile), the maximum annual overflow volume is around 2,500 ML/a. For wet conditions (10%ile), the maximum annual overflow volume reduces to around 65 ML/a. No overflows occurred from Dam 1 during median or drier conditions.

There is only a very small risk (around 1%) of an overflow from Dam 4 (Figure 9-50) occurring over the life of the Project, with a maximum annual overflow volume of 130 ML/a.

Environmental Dams 2D1 and 2D2 (to Deep Creek) are projected to have a similarly low risk of an overflow occurring over the life of the Project (around 1%), with a maximum overflow volume of 22 ML/a. Environmental Dam 1B (to Tooloombah Creek) has a very low risk (around 1%) of overflow during the first 10 years of the Project. In the second half of the Project, the risk increases to 10%. Under very wet conditions (1%ile), maximum annual overflows reach 700 ML/a, while under wet conditions (10%ile), they reduce to a maximum of around 180 ML/a.

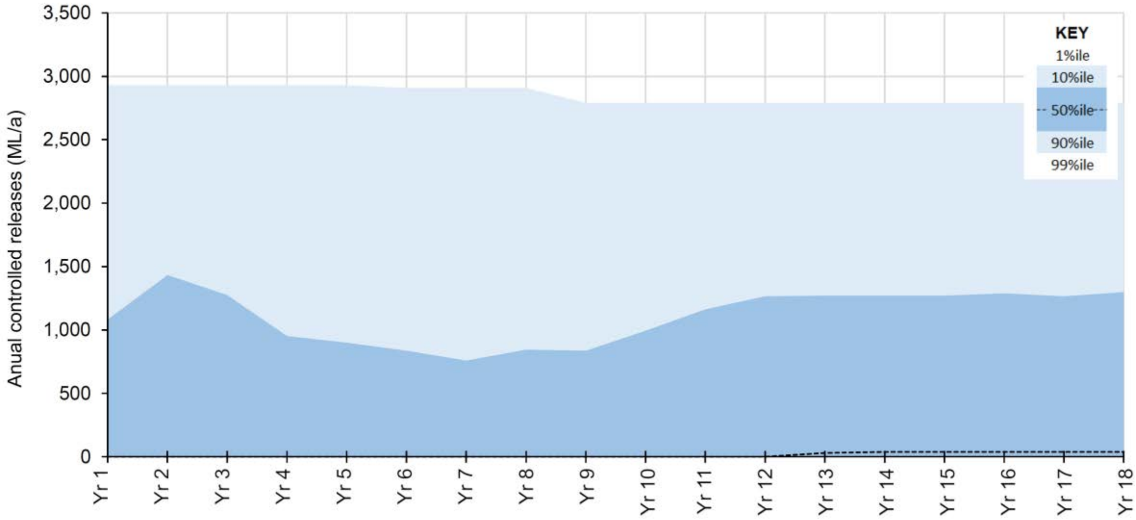

Figure 9-48: Controlled release volumes

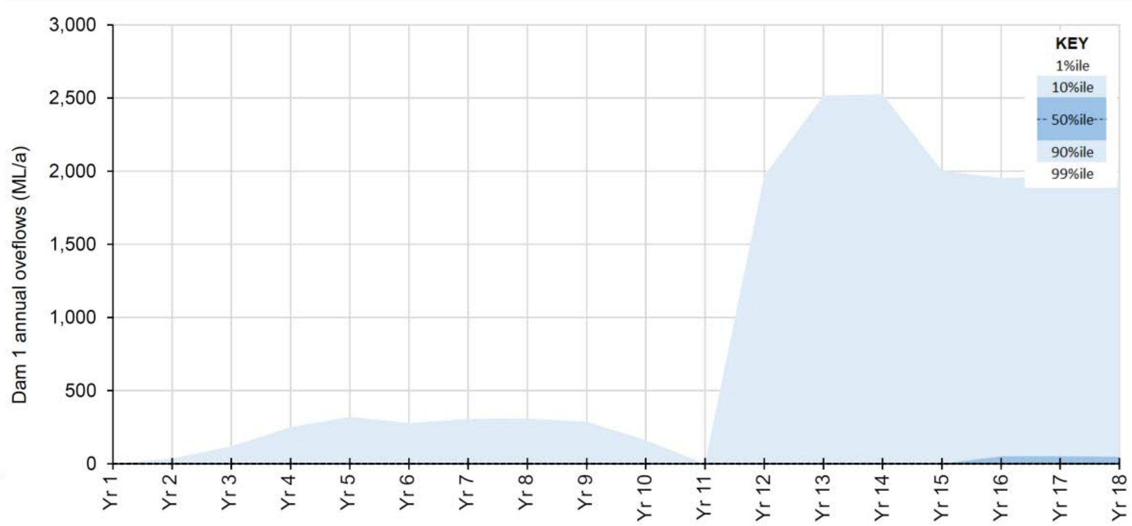

Figure 9-49: Forecast annual Dam 1 overflow volumes

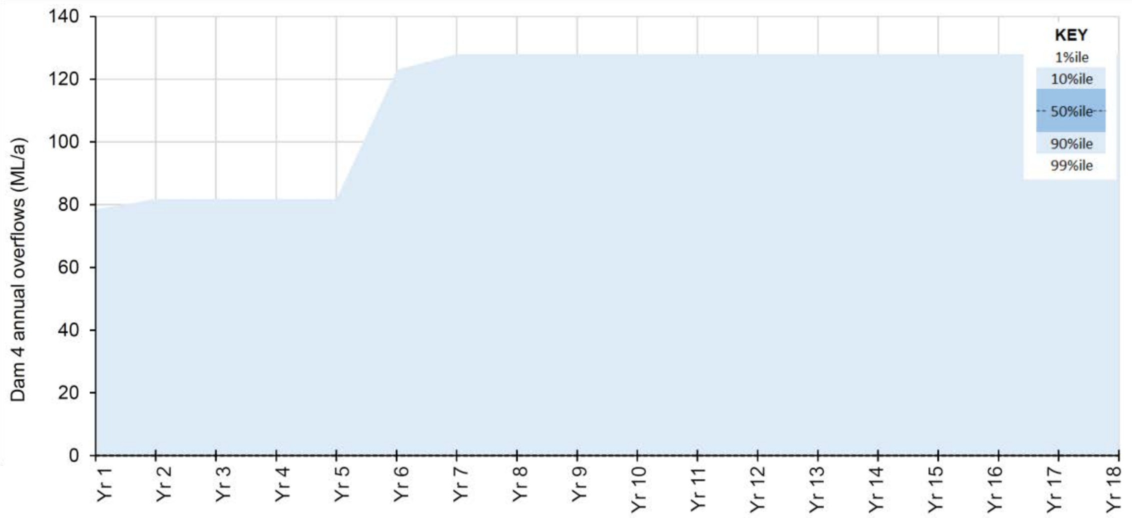

Figure 9-50: Forecast annual Dam 4 overflow volumes

9.6.4 Erosion and Stream Geomorphology

Due to the scale of disturbance on the site, a site-specific ESCP will be developed (with a draft plan provided in Appendix A15a). Erosion of water containing structures, such as constructed drains, bunds, dams and pit walls can be controlled through effective design and engineering controls, such as level spreaders, check dams, erosion control matting, vegetation and the like (refer to Appendix A15a). This will be an ongoing management requirement for the site, but will utilise common mitigation controls and given the large water storages able to capture sediment generated on the site, is not considered high risk if managed.

Waste rock and stripped soils have the potential to be highly sodic, which have the potential to cause slaking, are dispersive, and tend to be highly erodible. Proposed further soil assessment and soil management plans propose to ameliorate soils and stabilise soil stockpiles so they are non-erodible and stable, and do not erode over the time they are stored (prior to their reuse in rehabilitation works). Amelioration (with gypsum or similar) will minimise the erosion risk where spreading for rehabilitation works. Soil management planning is described in Chapter 5 – Land, Chapter 11 - Rehabilitation and Decommissioning and the Soil and Land Suitability Assessment in Appendix A3a.

For waste rock stockpiles, material characterisation, landform design and scheduling and design features summarised in Chapter 8 – Waste Rock and Rejects and Chapter 11 - Rehabilitation and Decommissioning, coupled with the use of sediment basins for both waste rock stockpiles, the waste rock stockpiles are not considered to pose significant management issues to the Project with respect to erosion.

The geomorphological assessment provided in the Supplementary Technical Study Report, Fluvial Geomorphology (Appendix A5d) assessed the risk of geomorphic change by comparing existing and developed (Year 8) scenario flood modelling outputs for maximum bed shear stress and velocity for the 10% and 1% AEP events, including locating potential areas of erosion risk.

For areas inundated under both the existing and developed (Year 8) scenarios there was negligible difference in velocity distribution. Under both the 10% AEP and 1% AEP events, areas inundated under the developed scenario, but not the Existing scenario - i.e. the northern catchment diversion drain, and a small area west of Open Cut 2, had velocities generally less than 1 m/s, which would be stable under good grass cover. The exceptions were under the 1% AEP event at the following locations:

- Two locations where velocity is between 1 – 2 m/s
  - in the 400 m-long area where drainage to the west of Open Cut 2 concentrates and then discharges to Tooloombah Creek and
  - where sub-catchments upstream of the mine discharge to the northern catchment diversion drain and
- a short section of the northern catchment diversion drain where it discharges to Deep Creek has a short section where velocity exceeds 2 m/s.

A number of areas were also identified as showing elevated bed shear stress, including the above locations.

Overall, six locations were identified as having the potential for scour and instability, requiring monitoring and stabilisation works (refer to Figure 9-51):

1. the 400 m-long area where drainage west of Open Cut 2 concentrates, then discharges to Tooloombah Creek
2. the discharge channel from Dam 1 to Deep Creek
3. where sub-catchments upstream of the mine discharge to the northern catchment diversion drain
4. the northern catchment diversion drain, particularly the lower 500 m
5. at the proposed haul road crossing over Deep Creek[12] and
6. an isolated location near Dam 1 wall.

Sites 1 and 3 are risk areas for gully formation. They will require maintenance of good vegetation cover and regular monitoring of stability, plus preparation of a plan to fortify them with rock rip-rap should significant incision occur. Site 4, the lower end of the northern catchment diversion drain where it discharges to Deep Creek, will require fortification with rip-rap or similar. Site 2 is likely to require fortification with rip-rap or similar to eliminate the risk of formation of knickpoints that could migrate towards Dam 1 embankment. Site 5, at the proposed haul road crossing over Deep Creek, was predicted to experience bed scour. This risk can be managed by designing the bridge crossing in accordance with civil engineering design standards.

Site 6 was an isolated area about 50 × 50 m near Dam 1 wall with modelled increase in bed shear stress and velocity for the 1% AEP event. However, examination of the topography and modelled flood depths indicate the effect is due to a localised high point, with the dam wall confining flows and increasing the water surface slope in the model significantly compared to the existing case. However, in the developed scenario, the bed shear stress was less than 80 N/m^2 and velocity less than 1.7 m/s. As such, provided the area remains vegetated, the risk of scour would be low.

Overall, while some areas were identified as requiring ongoing monitoring, the risk of rapid and significant geomorphic change in Tooloombah and Deep creeks and the Styx River due to the proposed mining activity was negligible to low (refer Appendix A5d).

[12] Note that this is incorrectly identified as the 'proposed rail bridge crossing' – the rail will not cross any major waterways, with two first order streams being intercepted by Dam 4 or passed through the rail loop

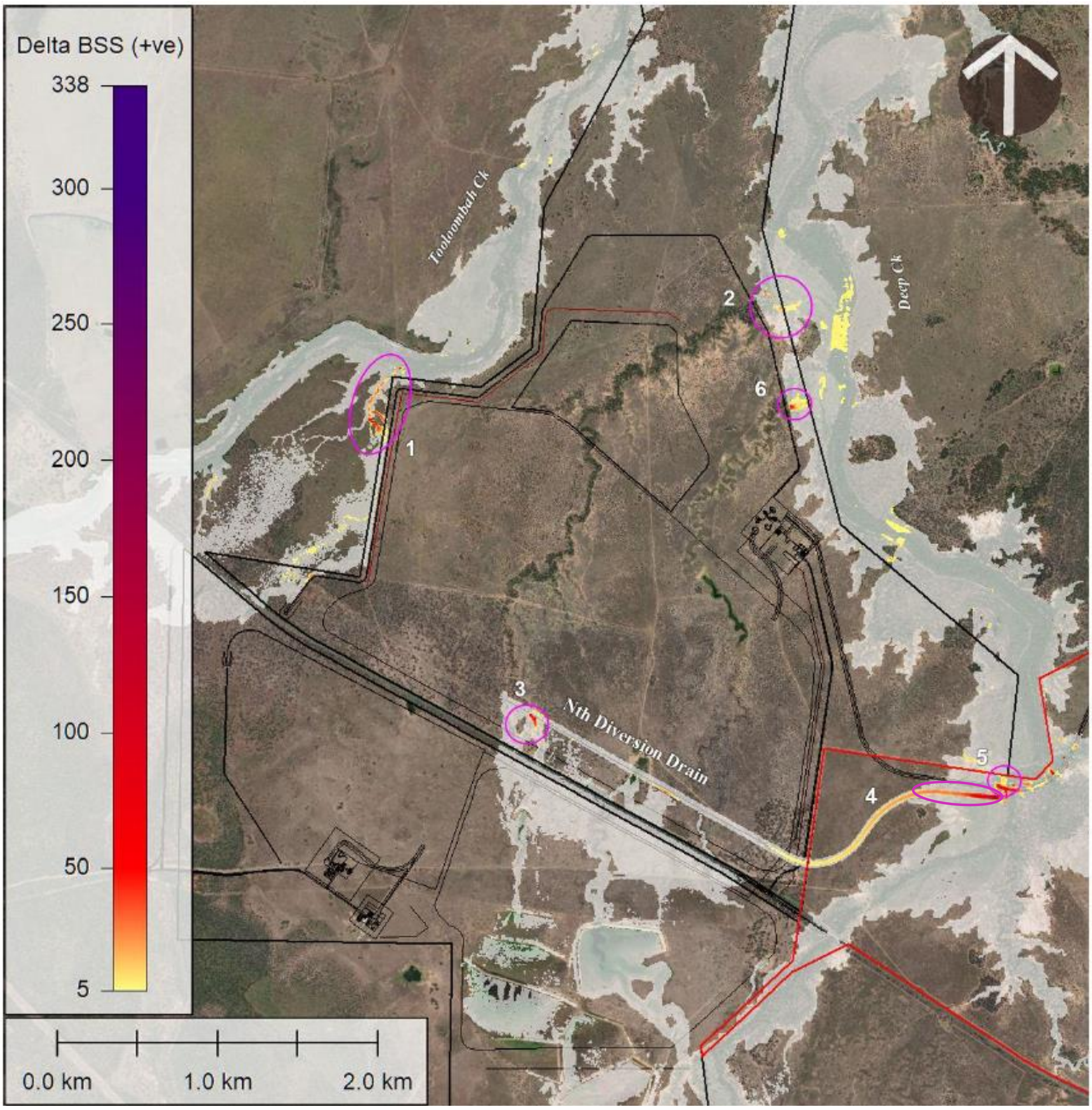

Figure 9-51: Identified potential areas of instability (from Appendix A5d)

9.6.5 Water Quality Impacts

Water on the site is managed under an overall Water Management System, involving segregating and management of waters differently on the site depending on water quality, namely:

- Clean up-catchment water, to be either diverted around the site or captured in site storages and used for the Project
- Sediment only contaminated water, such as from haul roads and soil or relatively clean rock emplacements and
- Potentially contaminated waters, comprising low level contaminants (such as from ROM pads and MIA / CHPP) – typical mine affected water - and high level contaminants (such as oil, fuel and chemical storages).

Sediment only contaminated waters are directed through sediment basins, or Dam 1, where settlement would occur to achieve required discharge quality. Typically under the IECA (2008) design approaches for construction activities, sediment basins would be expected to not exceed 50mg/L for the design storm (the State Planning Policy, July 2017, states the objective as 'at least 80% of the average annual runoff volume of the contributing catchment treated (i.e. 80% hydrological effectiveness) to 50mg/L Total Suspended Solids (TSS) or less').

Oil, fuel and chemical storages, and other wastes such as general waste and contaminated wastes will be managed for nil discharge, typically bunded and/or roofed, with any incident stormwater managed to remove contaminants before any release, or removal off-site.

For mine affected water releases, the site water balance model was configured to account for a suite of water quality parameters, tracking the loads and concentrations from sources, through the dam system and into the downstream receiving waters. As described in Section 9.2.7, EC, sulfate, arsenic, molybdenum, selenium and vanadium were modelled – the first two as they are commonly adopted indicators of potential water quality impacts due to mining, and the latter four selected based on findings of the Geochemical Assessment of Waste Rock and Coal Reject report (Appendix A3b).

Adopted concentrations for the various sources and predicted concentrations of the parameters within Dam 1 are detailed in the technical report in Appendix A5b, and summarised in Figure 9-52. The results show that EC peaks in the first half of the Project (median 5,000 – 10,000 µS/cm) before declining to less than 5,000 µS/cm in the second half. Sulfate follows a similar pattern, with the other parameters showing a generally stable or slightly increasing trend in concentration over the Project life.

The potential impacts of controlled releases and uncontrolled overflows from the mine water management system for each of the six modelled water quality parameters was assessed against the background concentrations in receiving waters. The modelling was conducted for three climatic scenarios, adopting an 18 year period from the climatic period used in the overall water balance modelling to that best represented the relevant climatic conditions, as follows:

- the 1%ile (very wet) climatic conditions adopted the 1890 – 1907 period
- the 10%ile (wet) climatic conditions adopted the 1938 – 1955 period and
- the 50%ile (median) climatic conditions adopted the 1970 – 1987 period.

The analysis was conducted for each day that a controlled release or uncontrolled overflow occurred was analysed. The days for which there was no release of water from the water management system (i.e. the majority of the time) were not assessed.

All parameters were found to be well within the range of the typical historical receiving water concentrations, and as such, releases from the site water management system are predicted to have no impact on downstream water quality. The modelled EC and sulfate concentrations in the receiving waters for the three selected realisations are shown in Figure 9-53. The other analytes show a similar pattern but smaller range (the lines are flatter), and are shown in the Flood Study and Site Water Balance Technical Report in Appendix A5b.

The release rules are based on a minimum dilution ratio of 5, so that the receiving water flow rate is at least 5 times greater than the release rate. As the receiving water flow rate increases, the target dilution ratio also increases so that the receiving water flow volume is 30 to 80 times greater than the release volume.

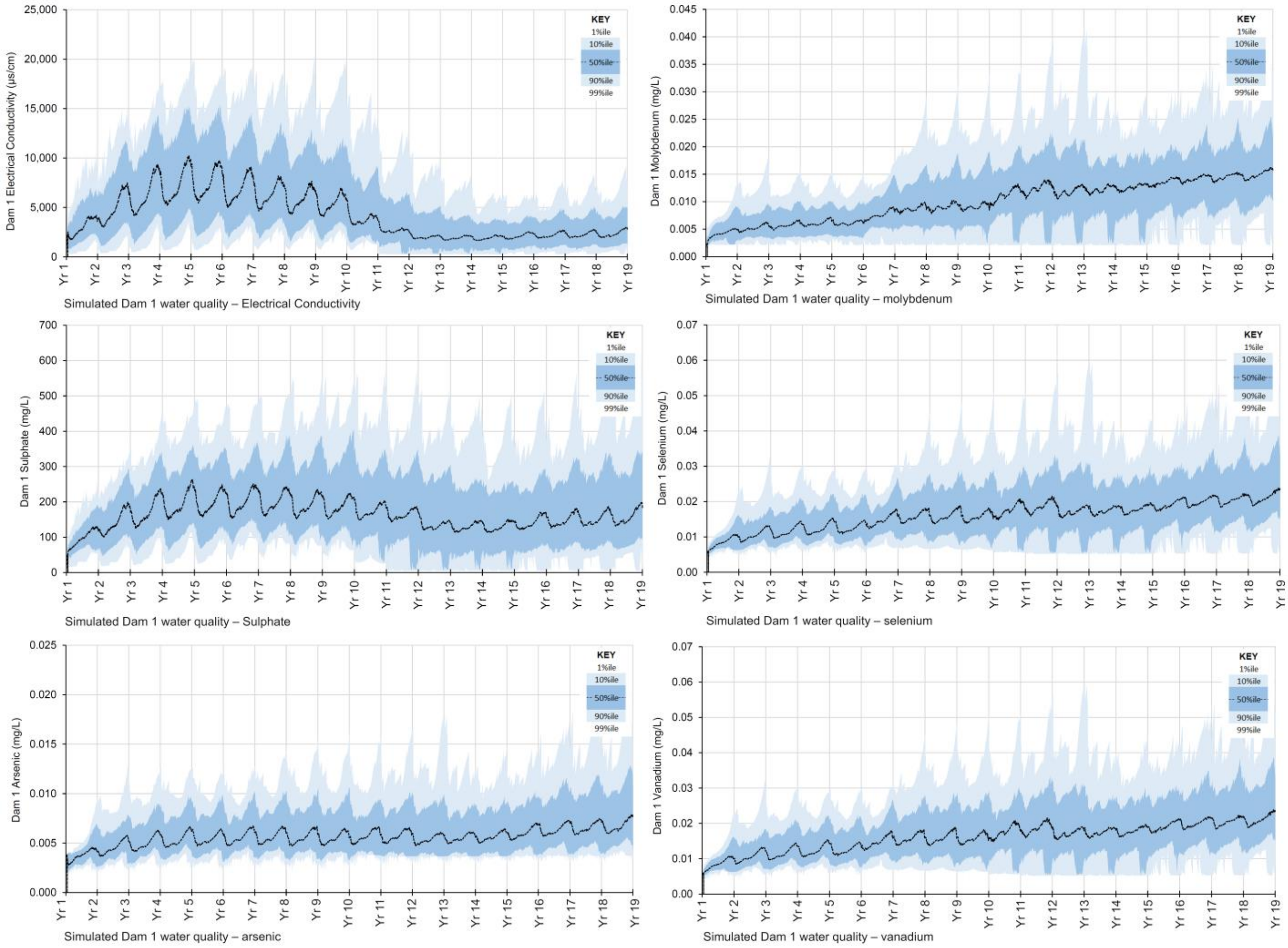

Figure 9-52: Dam 1 simulated water quality (after WRM 2020)

The results of the water balance above show that releases from Dam 1 to Deep Creek (both controlled and uncontrolled releases) will result in only small changes to downstream water quality with downstream water quality expected to remain within the range of natural variability. For other analytes not measured, the results are anticipated to be the same, given that these results are conservative, being based on a non-reactive mass balance (i.e. no deposition, uptake or other changes).

The assessment was conducted based on data available at the time of the assessment, and for stormflows only. Since that time, additional data has become available, and the site-specific trigger values and stormflow statistics revised. Table 9-17 shows the maximum modelled concentration in receiving waters from the Flood Study and Water Balance in Appendix A5b with the trigger values from Section 9.4.6, with stormflow 80th percentiles for EC and sulfate from the Surface Water Quality Technical Report in Appendix A5a (these are lower than the trigger values in Section 9.4.6). The results show that all parameters remain within the range of natural variability, and therefore the conclusions remain valid.

Table 9-17: Comparison of modelled receiving water quality with SSTVs

Parameter	Statistic (mg/L)		Maximum modelled concentration (mg/L)
Deep Creek			
EC	Stormflow, 80th %ile	355	<330
Sulfate	Stormflow, 80th %ile	10	<8
Arsenic	SSTV, all data	0.013	~0.004
Molybdenum	SSTV, all data	0.034	<0.004
Selenium	SSTV, all data	0.010	<0.008
Vanadium	SSTV, all data	0.010	<0.008
Tooloombah Creek			
EC	Stormflow, 80th %ile	357	<260
Sulfate	Stormflow, 80th %ile	15	<10
Arsenic	SSTV, all data	0.013	<0.004
Molybdenum	SSTV, all data	0.034	<0.003
Selenium	SSTV, all data	0.010	<0.006
Vanadium	SSTV, all data	0.010	<0.006

Using the generated 80th percentile statistics for stormflows to May 2020 provided in the Surface Water Quality Technical Report in Appendix A5a for EC (355 and 357 µS/cm for Deep and Tooloombah Creek respectively) and sulfate (10 and 15 mg/L for Deep and Tooloombah Creek respectively) shows that all results are still within natural variation. For the metals, insufficient stormflow data is available. Based on statistics for all flow data (storm, base and no flow events in Appendix A5a), the modelled concentrations for all metals are also below the SSTVs.

There is a possibility (although considered low risk) that groundwater seeping to surface waters could represent an impact pathway. However, the groundwater assessment (Appendix A6b) concluded that no appreciable change in groundwater quality was likely as a result of the Project, with appropriate control of ex and in-pit waste storages.

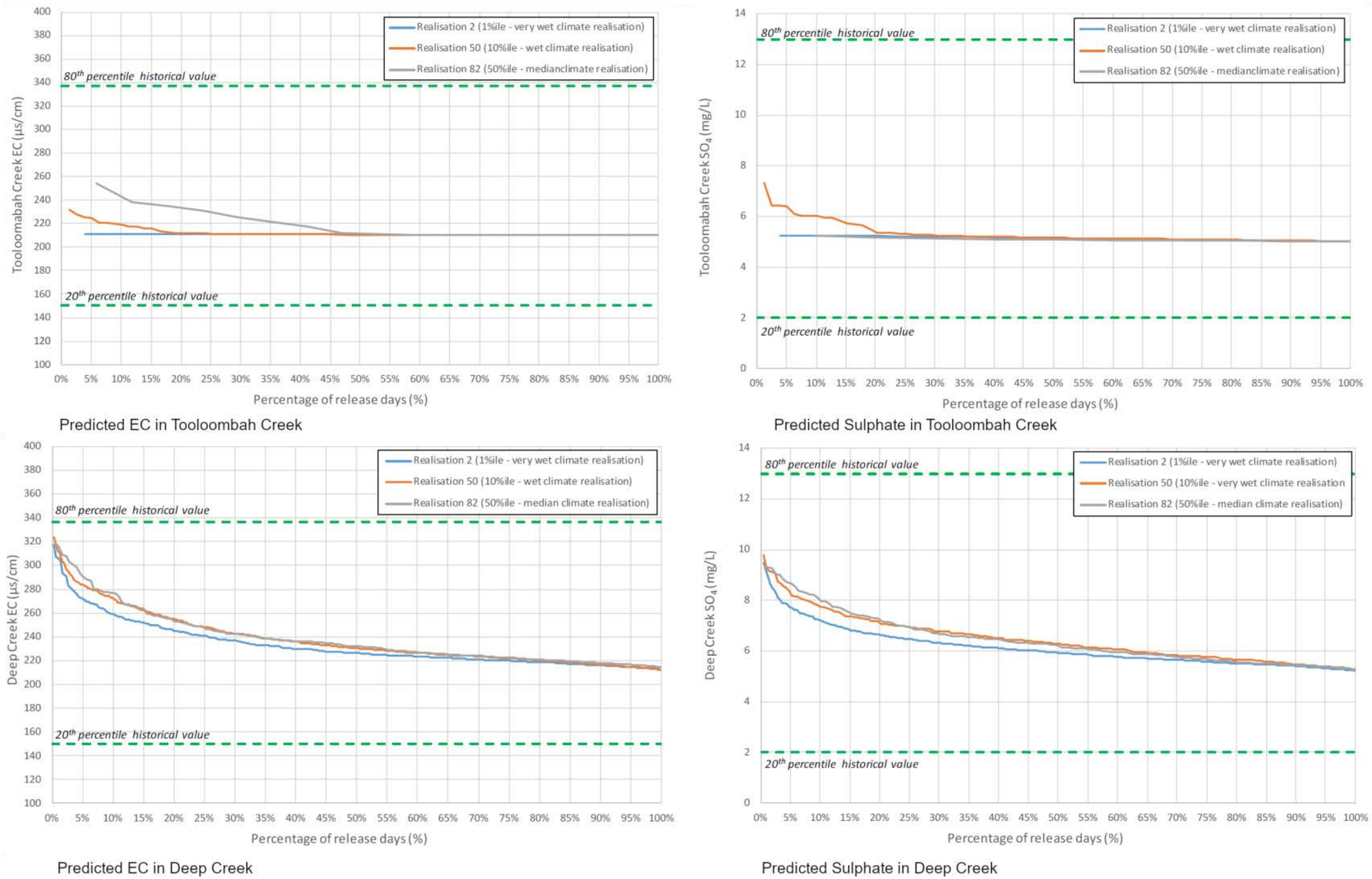

Figure 9-53: Predicted EC and Sulfate in Deep and Tooloombah Creeks – percentage of time on release days

9.6.6 Sediment Export

Given the existing grazing land management on the site, and the planned destocking of the Mamelon property coupled with ESCs on the site, the sediment loads assessment provided in Appendix A15b estimated that sediment loss rates would approximately halve, resulting in an overall improvement in water quality.

The fluvial geomorphological assessment provided in Appendix A5d identified potential sources of high sediment loads to the local creeks from alluvial gullies and small tributaries incised into old alluvium, but found that broadly there was negligible change in velocity and bed shear stress due to the Project. A number of areas were identified with the potential for higher risk of erosion and instability. However, with routine monitoring and, where required, mitigation, this is not expected to result in changes to water quality. Geomorphic monitoring is presented in Section 9.7.5 to ensure these, and other areas of instability not identified in the report, are identified and rectified as required.

As such, the Project is expected to result in a net reduction in sediment loads exported from the catchment which more than supports the current target of 'Maintain Current Loads' for the Styx Basin (DES 2019c).

9.7 Mitigation, Management and Monitoring

9.7.1 Flood Mitigation and Stormwater Drainage

Flood modelling indicates that development flood levels result in minimal changes to the overall flood levels external to the site, and provides for suitable Project immunity to the 0.1 % AEP event. To mitigate flooding in the post mining landforms, the backfilled mining pits will include realigned drainage paths to drain local runoff, as well as any flow breakouts from Deep Creek, to Tooloombah and Deep creeks, with the concept drainage paths shown in Figure 9-42.

Detailed design of the reinstated drainage paths across the backfilled mining pit will be undertaken to ensure that the final landform will be stable in the long term, with flows conveyed at non-erosive velocities. Detailed design will be integrated with rehabilitation planning and will include consideration of soil resources, vegetation and hydraulic characteristics. The design approach will reference hydraulic conditions along undisturbed local drainage paths as a template for design of stable flow paths on the rehabilitated site.

As part of detailed design, the existing flood model will be used, and where necessary, updated to ensure the drainage across the site, including post-mining, will continue to have a low flood impact. Ongoing monitoring of potential erosive / unstable areas will be conducted and mitigation works undertaken to ensure erosion does not occur, as outlined in Section 9.7.2 below.

Design for the stormwater system will be undertaken to ensure fish passage is maintained in creek crossings, and that local drainage is controlled and directed across the site in a low velocity non-erosive manner. Additional controls required ESC are discussed in Section 9.7.2 below.

An emergency response plan will be in force for the site, to ensure that control, containment and stabilisation of site structures, waste and potentially contaminating materials is undertaken prior to any storm or flood event. This is further described in Chapter 21 - Hazard and Risk.

9.7.2 Control of Erosion and Sediment

Control of erosion on and off-site will largely be managed under the site ESCP a draft of which is included in Appendix A15a, and summarised in this section. In addition, the destocking of Mamelon station, and planned revegetation and offsets protection on the site, including riparian areas, will aid in further reducing erosion and sediment loss from the site.

These are discussed in the sections below.

9.7.2.1 Removal of Stock

The Project is located on the Mamelon property, covering 6,478 ha of which the Project disturbance footprint covers approximately 1,372 ha (including the proposed new access road external to the lease). CQC has committed to destocking the majority of the Mamelon Property. Cattle grazing will be progressively decreased within the mining leases during the operational period and at approximately Year 10, no grazing is proposed within the entirety of the two leases. In addition, the adjacent offset area on Mamelon will be destocked and no grazing will occur within the offset areas, except on a periodic as-needed basis to manage fuel load and weeds. The total area to be destocked across the property is over 5,000 ha.

9.7.2.2 Revegetation

A revegetation program will be implemented in areas within the riparian corridor expected to be affected by groundwater drawdown with the aim of building ecological resilience. Revegetation will include expansion of the existing riparian corridor by a width of 10 m. A revegetation program will be designed to ensure the planting of drought tolerant species of similar ecological function as those with the potential to be impacted. This will ensure that existing habitat for terrestrial species is maintained, as well as reducing the potential for consequential impacts such as erosion and sedimentation which may be associated with vegetation loss. The revegetation program will be implemented from Project commencement ensuring sufficient timeframes for establishment of vegetation, given potential impacts are not expected to commence until at least 10 years after Project commencement.

In the longer term this measure will contribute to localised water quality improvements, and contribute to improving the water quality entering Broad Sound and the GBRWHA through the following:

- the long-term restoration of this habitat, and in particular allowing vegetation to regrow along the riparian zones along Deep Creek and Tooloombah Creek (which are presently mostly cleared), will capture / entrain sediment and nutrient run-off from the property
- the restoration of cleared areas will also reduce soil erosion on cleared areas of the property, thereby reducing the entrainment of sediments entering creek lines during bouts of heavy rainfall and
- the removal of cattle from much of the property will also remove a source of long-term nutrient input into creek lines following rainfall.

9.7.2.3 Erosion and Sediment Control Plan

A Draft ESCP has been prepared for the Project and is provided in Appendix A15a. It has been prepared with reference to the International Erosion Control Association (IECA) Guidelines (IECA 2008 and 2018 Appendix B revision), and the DES Guideline 'Model mining conditions', Version 6.02, 2017 (DES 2017). Requirements from the DES 'Manual for Assessing Consequence Categories and Hydraulic Performance of Structures' (DES 2016) and the DEHP 'Stormwater Guideline for Environmentally Relevant Activities' (EHP 2014b) were also considered.

The plan provides for management of the site and ESCs to effectively control erosion and sediment loss from the site, and will be updated prior to works commencing, and regularly as construction and mining works progress. It describes the proposed general strategies and controls for management of erosion and sediment.

In line with best practice guidelines for Queensland (the IECA Guidelines), the principles for development of ESCs required for the Project include:

- appropriately integrate the development into the site
- integrate ESC risks into site planning and construction planning
- develop effective and flexible ESCPs based on anticipated soil loss, weather, and construction activities
- minimise the extent and duration of soil disturbance
- control water movement through the site
- minimise soil erosion
- promptly stabilise disturbed areas
- maximise sediment retention on the site
- maintain all ESC measures in proper working order at all times and
- monitor the site and adjust ESC practices to maintain the required performance standard.

Soil erosion management shall be undertaken in a two season approach - the wet season (December to March) and dry season (April to November), and specific strategies for the different seasonal fluctuations have been developed.

Overall, the ESC strategy has been designed to manage the interrelated processes of drainage control (minimising water flows through erosion prone areas), erosion control (minimising the detachment of sediment), and sediment control (capturing sediment displaced by up-slope erosion processes). Therefore, the key strategies adopted in the ESCP will involve diversion of water flowing into disturbance areas, minimising erosion within the disturbance areas, and trapping the majority of sediment that is generated before it is mobilised off site. Vegetation clearing and land disturbance will be minimised to the extent required for each stage, stabilised entry/exit points will be maintained, and controls installed prior to works commencing. Design considerations for ESCs are included in the Draft ESCP.

9.7.2.4 Design of Constructed Landforms

The constructed landforms (i.e. the waste rock stockpiles) represent the largest erosion risk areas on the site if unmitigated. Chapter 11 - Rehabilitation and Decommissioning draws on the Land Stability Assessment in Appendix A3c and the Soil and Land Suitability Assessment in Appendix A3a to provide recommended controls for waste rock stockpiles (and other rehabilitation landforms), including temporary stabilisation of stockpiles prior to reworking to final landforms.

The waste rock stockpiles will be strategically developed, graded and compacted to ensure no internal pooling of water and to minimise the infiltration of water into the stockpiled materials. The stockpiles will be bunded around their perimeter to capture and divert any rainfall runoff from these stockpiled materials into the mine water management system.

Some weathered rock and other waste rock materials with the potential to become dispersive (and accordingly be susceptible to erosion) will be selectively handled and emplaced inside the waste rock stockpiles, or emplaced deep within the mining areas, and capped beneath suitable materials. Consideration will also be given to ensure this material is emplaced within areas which remain well below the level of the proposed final landform design to avoid the need to rehandle this material at mine closure. Materials characterised and validated as non-dispersive and non-sodic will be used for the outer slopes of waste rock stockpiles to limit the potential for dispersion and erosion

Further controls and commitments to ensure slope and landform stability are provided in Chapter 8 – Waste Rock and Rejects and Chapter 11 - Rehabilitation and Decommissioning.

9.7.2.5 Geomorphic monitoring and management

Geomorphic monitoring will be undertaken in areas of potential instability, including both potentially impacted areas and control sites that will not be impacted, to differentiate Project related impacts from regional changes. Data will be gathered from site volumetric survey conducted for mining operations, or alternative survey methods that provide the ability to detect change between monitoring events (such as ground survey). More regular site inspections will be conducted as part of the ESC management and monitoring system to detect short term changes, which will include all potential areas of concern.

The proposed geomorphic monitoring sites along with the proposed mitigation at each is summarised in Table 9-18. Monitoring is proposed to be undertaken at the following frequency:

- Topographic comparisons
  - once every year for the first three years, then every 5 years thereafter
  - following visual observations (refer next) that indicate ongoing geomorphic impacts
- Visual site inspections
  - inspect the sites in Table 9-18 with the regular inspections required under the ESCP.

Table 9-18. Proposed geomorphic process monitoring and mitigation

Site[1]	Location	Mitigation
1	The 400 m-long area where drainage from the western sub-catchments concentrates, then discharges to Tooloombah Ck	Ensure good vegetation cover
2	Discharge channel from Dam 1 to Deep Creek	Install and/or stabilise with rip-rap of similar
3	Where sub-catchments upstream of the mine discharge to the Northern Diversion Drain	Ensure good vegetation cover
4	The Northern Diversion Drain, particularly the lower 500 m (likely to also apply to the Southern Diversion Drain)	Construct to civil engineering design
5	At the proposed rail bridge crossing over Deep Creek	Construct to civil engineering design
6	An isolated location near Dam 1 wall.	Ensure good vegetation cover
Control Sites	Select from existing sites identified in Appendix A5d, upstream or outside of the flood impact area of the Project	N/A

Refer to Appendix A5d for further detail. Locations are described further in Section 9.6.4

9.7.2.6 Roads

Haul roads will be built up in most areas, so that they are above the natural land surface. They will be designed to be water shedding to avoid flow accumulation which can lead to scouring, and erosion of the road surface and embankments. Haul roads will be constructed using compacted native soil materials, which are generally high in gravel content and are therefore considered to be relatively erosion resistant. Sandstone or waste rock material will be additionally utilised where the upper soil profile is found to be unsuitable for road construction.

9.7.2.7 Dust Control

Wind erosion will be controlled through a combination of rock cover and water spraying, with erosive resistant materials placed over temporarily stabilised waste rockpile slopes prior to final reworking and rehabilitation. Most of the other disturbance areas are to be constructed using compacted native soils, which consist of a significant fraction of gravels to help armour the surfaces. Surfaces that require additional dust control measures, particularly areas that receive a significant volume of vehicle traffic, will also be periodically sprayed with water, as required.

Any additional cleared areas that are not required during the operation of the mine will be progressively rehabilitated according to the site rehabilitation strategy. This will restore a pasture cover to the land surface to support the post mine grazing landuse, plus areas of native trees and shrubs planted in selected areas of the rehabilitated landform to assist in the development of shade trees and to improve the blend the rehabilitated landform with the surrounding landscape. This will reduce the risk of dust generation from exposed bare soil surfaces.

9.7.3 Control of Pollutants and Contaminants

All contaminated water on-site will be collected using site environmental dams, preventing the water from entering local waterways. These dams will collect water from the MIA, CHPP, waste rock stockpiles, coal stockpile and the TLF. This water will be used to supplement the demands for stockpile dust suppression, washdown and CHPP demand.

In addition to the installation of environmental dams, the following management measures will be implemented to minimise the risk of pollutants and contaminants entering local waterways:

- Appropriate spill control materials including booms and absorbent materials will be onsite at refuelling facilities at all times. These will be used for mitigating and managing events where a substance is spilled into the surrounding waters.
- All refuelling facilities and the storage and handling of oil and chemicals will comply with relevant Australian Standards.
- Procedures will be established at the mine for safe and effective fuel, oil and chemical storage and handling, in accordance with relevant standards, including AS1940 - The storage and handling of flammable and combustible liquids. This includes storing these materials within roofed, bunded areas with a storage capacity of 100% of the largest vessel and 10% of the second largest vessel. The bunding will have floors and walls that are lined with an impermeable material to prevent leaching and spills.
- Wash-down areas for plant and equipment will be clearly marked to prevent contaminated water from leaching into soils or flowing into nearby watercourses.

- The Emergency Response Plan for the site (refer Chapter 21 - Hazard and Risk) will include controls required to ensure adequate control of wastes and other potential pollutants on the site, including:
  - Prior to the start of the wet season, the site will be prepared by ensuring all waste materials, receptacles and storages are properly contained and stable, and will be able to withstand wet season rainfall without leaching or other loss of contaminants.
  - A site audit will be conducted prior to each wet season with the results provided internally in written form.
  - A similar process will occur prior to forecast storms or other extreme weather events, whereby all wastes are contained and restrained so as to avoid loss of materials during the event.

9.7.4 Monitoring for Seepage

The detailed design of the environmental and water dams on site will consider and make provision for the detection and management of seepage where it may result in safety and / or water quality impacts to the receiving environment. In general, the site water management strategy indicates that mine-impacted water will be of good to moderate quality, despite having been in contact with coal and / or sediment. Seepage has been considered in the consequence category of the dams. The site water management plan will address monitoring, including visual inspections for seepage from embankments, along with trigger and action plans based on the volume, rate and quality detected.

9.7.5 Waste Rock Management Plan

A detailed Mine Waste Management Plan (MWMP) will be prepared for the Project including:

- effective characterisation of the mining waste to predict, under the proposed placement and disposal strategy, the quality of run-off and seepage generated including salinity, acidity, alkalinity and dissolved metals, metalloids and non-metallic inorganic substances
- mineral waste field and laboratory testing procedure for validation of the acid-forming and potential erodibility characterisations of each phase
- classifying waste rock zones (based on acid forming potential, salinity and sodicity), placement and use of waste rock materials and appropriate disposal of PAF waste or waste designated as not suitable for use on final surfaces (including potential PAF material identified during mining)
- ex-situ waste rock stockpile design criteria, including preferred selective placement of each waste domain, stockpile heights, stockpile profiles, conceptual final landform design
- monitoring and management of erosion, groundwater and surface water (including run-off and seepage) at ex-situ waste landforms and
- progressive rehabilitation strategies, including a site wide hydro-geochemical model to assist with waste rock stockpile design, water management and closure planning.

9.7.6 Water Management System

The water management system will be operated in accordance with a Water Management Plan, a draft version of which has been prepared and provided in Appendix A5c. The plan covers operating and controlled release rules, monitoring and mitigation and includes trigger-action-response-plans to simplify linking monitoring results with appropriate action.

Monitoring will be conducted as outlined in the plan in Appendix A5c, which includes:

- Water quantity – volumes of water in site storages, transferred between storages and used in site processes will be recorded or estimated (e.g. for evaporation) to understand the key processes on site and validate the water balance model.
- Water quality – on-site and off-site receiving water monitoring to provide information for releases, early warning of potential impacts and to detect impacts that may have occurred.
- ESC inspections and monitoring (see also Section 9.7.2.3).

Once mining operations commence, the site water balance model will be updated to reflect the as-constructed configuration of the water management system and verified against recorded site data (such as dam water levels, pump metering etc). The model will be retained and updated as required to assist with ongoing management of the site water system.

9.7.7 Monitoring Program

The Project has three proposed mine affected water release points, and an additional three sediment basin discharge locations, although these will preferentially be dewatered to Dam 1 rather than overflow, where practicable (see Section 9.4.3). Water monitoring will be undertaken at the environmental dams, mine-affected water dams, discharge locations and locations both upstream and downstream of the Project area.

A Receiving Environment Monitoring Program (REMP) has been developed, with the draft REMP shown in Appendix A10f. The Draft REMP has been developed in accordance with the 'Receiving Environment Monitoring Program guideline - For use with Environmental Relevant Activities under the Environmental Protection Act 1994' (DES 2014). It outlines:

- monitoring requirements for flow monitoring, water quality, sediment quality, macroinvertebrates, fish and mangrove distribution, for both fresh and estuarine / marine areas
- proposed receiving environment monitoring sites, and their timing and frequency
- parameters to be sampled
- field sampling procedures and laboratory analysis requirements, including quality assurance and quality control procedures and samples and
- data analysis, reporting and review.

The overall surface water monitoring program is summarised in Table 9-19, using the proposed programs from the Draft Water Management Plan (Appendix A5c), the REMP (Appendix A10f), geomorphic monitoring program (Section 9.7.2.5), Draft ESCP (Appendix A15a) and Surface Water Quality Technical Report (Appendix A5a).

The REMP monitoring locations are shown in Figure 9-54.

9.7.8 Trigger Action Response Plans

Trigger Action Response Plans (TARPs) will outline actions and responses necessary should monitoring identify exceedances in the Project water quality criteria (trigger levels). In addition, the TARP will outline the criteria, monitoring and reporting measures for environmental incidents, unplanned events or cases of unauthorised discharge. Draft TARPs have been included in the Draft Water Management Plan (Appendix A5c) and in the sub plans in Appendix C to the Draft Environmental Management Plan (SEIS Appendix 12). These will be finalised once EA conditions are finalised and will be incorporated into the overall site monitoring program, including the Water Management Plan and REMP.

The incident reporting processes to DES will be completed as per the EA conditions.

Table 9-19. Summary of proposed surface water monitoring program

Element	Source Programs / Reports[1]	Monitoring Locations	Parameters[2]	Frequency
Water Quality	WMP REMP	Freshwater, St1 and St2 receiving water sites identified in Figure 9-54	Phys-chem, major cations and anions, total and dissolved metals and metalloids, nutrients, organics	Monthly or when daily rainfall > 50mm 1 – 2 days after first flush in wet season During and/or in the days immediately following a mine affected water release
		Marine Sites identified in Figure 9-54		Quarterly
		Dam 1		Quarterly
		Dam 1 release points		Daily during releases
		All site dams	pH, EC, turbidity (field)	Monthly or when daily rainfall > 50mm Release points daily when releasing
Water Quantity	WMP REMP	On site	Rainfall	Continuous
		CHPP	CHPP water consumption	Monthly
		Mine Water Dam 1	Total water volume for dust suppression	Monthly
		Mine Water Dam 1	Water level	Weekly
		Mine Water Dam 1 Release point	Flow rate	Continuous during releases
		Tooloombah Creek and Deep Creek flow gauging stations	Flow rate	Continuous
		Open Cut Pit	Pit water level	Weekly
			Volume of pumping from pit	Weekly
Erosion and Sediment Control	WMP ESCP	Sediment Dams	Inspection to assess sediment accumulation	Monthly or when daily rainfall > 50mm
		Sediment Dams	Evidence of overflow	Daily rainfall > 50 mm
		Clean & sediment laden water drains	Inspection for erosion damage or sediment accumulation	Monthly or when daily rainfall > 50mm

Element	Source Programs / Reports[1]	Monitoring Locations	Parameters[2]	Frequency
Geomorphic Monitoring	FG	Locations identified in Section 9.7.2.5	Topographic comparisons	Once every year for the first three years, then every 5 years thereafter Following visual observations (refer next) that indicate ongoing geomorphic impacts
			Visual site inspections	As part of regular ESCP site inspections
Sediment Monitoring	REMP	Freshwater and marine sites identified in Figure 9-54	Total metals (total and dissolved metals and metalloids in footnote to table, plus antimony and cobalt) Particle size distribution Total organic carbon	Twice per year: At start of wet season 4 – 6 weeks after first flush (Oct – Nov) Post wet season when flows have ceased (Jun – Jul)
Macroinvertebrates	REMP	Freshwater sites identified in Figure 9-54, excluding St2, Mam01, Mo2, Ba1x, Am1	Physical habitat assessment Presence and abundance	
Fish	REMP	Freshwater sites identified in Figure 9-54, excluding Mam01, Mo2, Ba1x, Am1	Presence and abundance Total length, general health assessment	A third targeted sampling of surface pools within Tooloombah and Deep Creek prior to the wet season (Aug-Sep)
Mangrove Monitoring	REMP	Styx River and Waverley Creek Estuaries, as identified in the draft REMP	Size and extent of mangrove habitats utilising satellite imagery	Once every 3 years

Table notes:

1 WMP – Draft Water Management Plan (Appendix A5c), REMP – Draft Receiving Environment Monitoring Program (Appendix A10f), SWQTR – Surface Water Quality Technical Report (Appendix A5a), ESCP – Draft Erosion and Sediment Control Plan (Appendix A15a), FG - Supplementary Technical Study Report, Fluvial Geomorphology (Appendix A5d)

2 Phys-chem – EC, pH, dissolved oxygen, temperature, turbidity; Major cations and anions – alkalinity (hydroxide, carbonate, bicarbonate, total) as $CaCO_3$, hardness, sulfate, chloride, fluoride, dissolved major cations (calcium, magnesium potassium, sodium); Total and dissolved metals and metalloids – aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, vanadium and zinc; Nutrients – ammonia, nitrate, nitrite, nitrate + nitrite, total kjeldahl nitrogen, total nitrogen (all as N), filterable reactive phosphorous, total phosphorous (both as P); Organics – total recoverable hydrocarbons

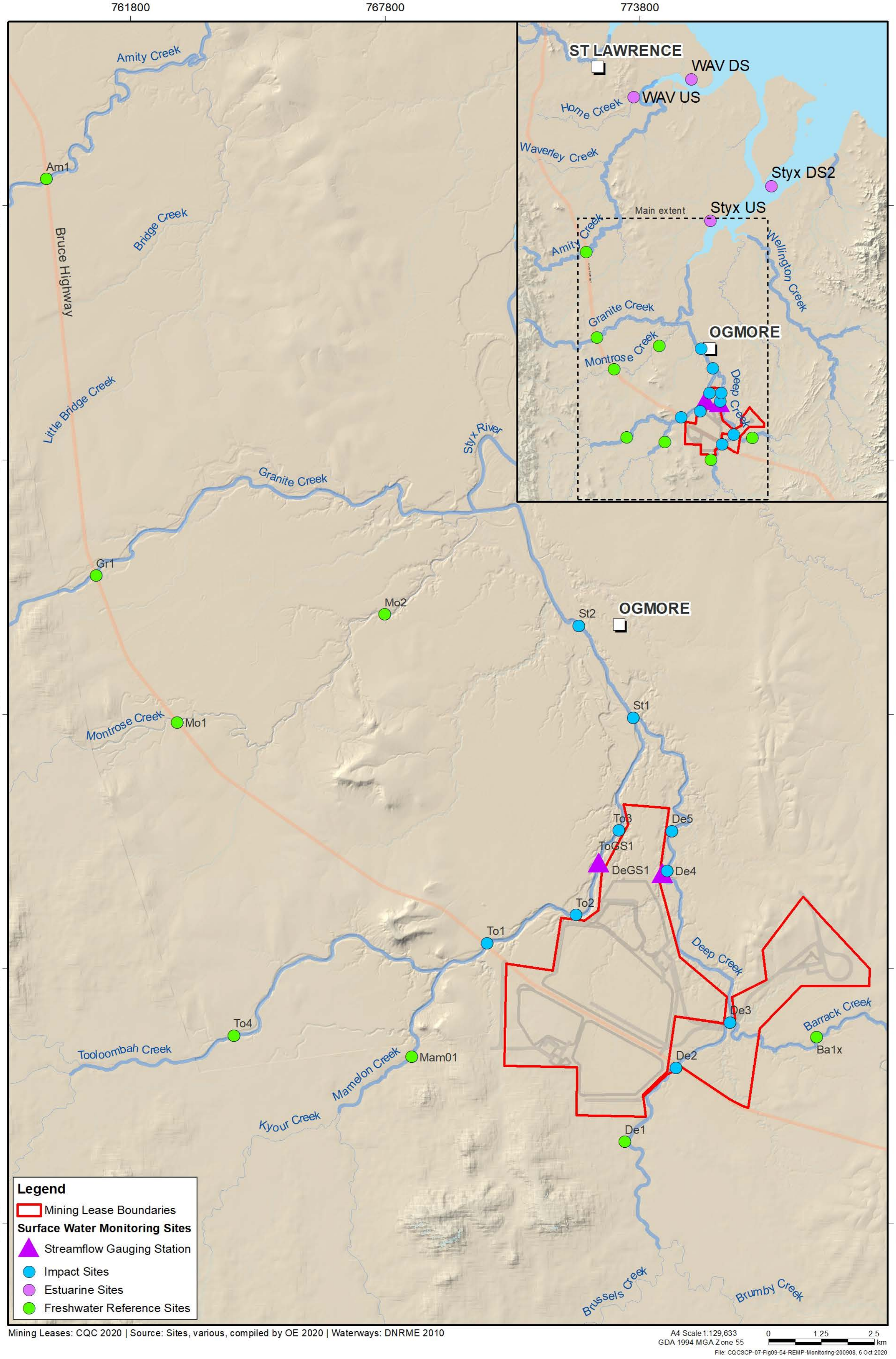

Figure 9-54: Proposed REMP monitoring locations

9.8 Cumulative Impacts

The Project may have impacts on environmental values that act cumulatively with those of other projects in the region. The contribution of past and present projects is inherent in the impact assessment, as these projects are influencing the environmental baseline upon which the impact assessment is based. However, reasonably foreseeable future projects should also be considered, in the context that these projects may have environmental impacts that act cumulatively with those of the Project.

The catchment and coastline surrounding the Project Area is relatively undeveloped, dominated by rural lands that are used for grazing. There are no known large-scale industrial or mining developments proposed within the catchment of the Project. The Commonwealth Department of Defence is currently developing an expansion of the existing Shoalwater Bay Defence Training Area. A future expansion of the existing Shoalwater Bay Defence Training Area is located partly in the catchment of Broad Sound, approximately 50 km to the north-east of the Project. Therefore, there is some potential for the impacts of the Project to act cumulatively with those of the Defence project. Potential cumulative impacts relate to changes to water quality within Broad Sound and parts of the GBR, and associated disturbance to marine habitats such as seagrass communities. However, the potential for cumulative impacts is considered to be very low, because:

- Impacts of the Project on downstream values including water quality are not expected, particularly as far downstream as Broad Sound.
- Broad Sound and Shoalwater Bay are subject to a very large tidal influence, reducing the risk of cumulative impacts on water quality from both projects.
- The Defence project will be implemented in accordance with environmental guidelines to mitigate impacts on the environment, including local water quality values.
- The Project will result in a net reduction in sediment discharges to the GBR, reducing the risks of impacts from sediment discharges acting cumulatively with the Defence project.

In terms of water take from local surface waters, there are three surface water entitlements in Tooloombah and Deep Creek. The existing water entitlements are small with extraction entitlements of 18 ML in Tooloombah Creek, and area limits for the other two (one in Tooloombah, the other in Deep Creeks). Reduction in flows to the creeks is projected to be negligible due to the Project, and the 18 ML extraction limit represents around 0.1% of the total median creek flow. As such, any cumulative pressure on creek volumes will be negligible.

Impacts on water quality in the catchment are currently limited to grazing, and since grazing pressure on the Project site is to be reduced, riparian vegetation strengthened and given that changes to downstream water quality are also negligible due to both controlled and uncontrolled releases, no cumulative pressure on receiving water quality is anticipated.

Overall, as there are no known current, or proposed, significant developments that will be additive to this Project, there are unlikely to be surface water cumulative impacts associated with the Project.

9.9 Qualitative Risk Assessment

Potential impacts on ecological values have been assessed utilising the risk assessment framework outlined in Chapter 1 - Introduction and Project Description.

For the purposes of risk associated with aquatic EVs, risk levels are defined as follows:

- Extreme – Works must not proceed until suitable mitigation measures have been adopted to minimise the risk.
- High – Works should not proceed until suitable mitigation measures have been adopted to minimise the risk.
- Medium – Acceptable with formal review. Documented action plan to manage risk is required and
- Low - Acceptable with review.

A qualitative risk assessment is outlined in Table 9-20. It outlines the potential impacts, the initial risk, proposed control measures (as detailed in the previous section), and the residual risk following the implementation of those measures.

Table 9-20: Qualitative risk assessment

Issue	Potential impacts	Potential risk	Mitigation measures	Residual risk
Increased Sedimentation of Waterways and Sediment Runoff	• Degradation of instream habitat / water quality including downstream estuarine habitat in the Styx River • Changes flood extent as less storage available for rainfall events	High	• Design and implement Project ESCP • Surface waters managed and monitored under Project Receiving Environment Monitoring Program • Minimise unnecessary disturbance to vegetated lands • Progressive rehabilitation of disturbed areas will be undertaken • Appropriately designed water management system including environmental dams	Low
Direct Disturbance of Waterways	• Changes to flow characteristics • Changes in sediment loads • Decrease habitat • Increased erosion and increase in runoff velocity due to the construction of culverts • Causes localised surface water ponded areas	High	• Construction of culverts, and watercourse / drainage feature crossings and diversions during low-flow conditions • Implementation of requirements set out in the ESCP • Vegetation will be preserved with only the minimum amount of land required to operate the Project cleared at any one time • Monitor the crossings and ESC to ensure ongoing effectiveness and implement corrective actions should a fault in the crossings or ESC devices be identified	Low
Accidental release of pollutants	• Degradation of instream habitat/water quality including downstream HEV estuarine habitat in the Styx River • Fish mortality events • Decreases in water quality i.e. lower DO levels, higher turbidity	High	• Design and implement Project Receiving Environment Monitoring Program and Water Management Plan • Controlled release of better quality water in accordance with licensed EA conditions • Maintenance of Design Storage Allowance on the onset of the wet season to minimise the likelihood of uncontrolled discharges • Pipeline connectivity between storages to allow water transfer to where there is available capacity • Establish measures to minimise/control Project-associated chemical spills	Medium

Issue	Potential impacts	Potential risk	Mitigation measures	Residual risk
			• Project design will locate infrastructure to minimise stormwater run-off • All waters discharged into adjacent waterways will be treated in retention basins and similar in quality to receiving waters	
Hydrology and water flows	• Reduction of inflows to watercourses and drainage features	High	• Design and implement Project Receiving Environment Monitoring Program • Project design to ensure surface water flows into creeks maintained as close to natural conditions as practical	Low

Note: R=Rare, UL= Unlikely, P=Possible, L=Likely, AC=Almost Certain

9.10 Conclusion

This chapter described the environmental values of surface water resources that may be affected by the Project, and identified historical and current surface water conditions upstream, downstream and within the Project area. The ephemeral watercourses and wetlands (including farm dams) within the Project area and surrounding region are classified as moderately disturbed, with the background water quality reflecting that the land is largely given over to grazing.

Intermittent flooding is a natural feature of the landscape, reflected in the predominance of ephemeral watercourses. Flood modelling identified that the majority of flow is confined within the creek banks, with minor flooding through the mine site in the 1% AEP event. The probable maximum flood event modelling shows that the Open Cut 1 processing and waste storage areas (MIA & CHPP 1, Environmental Dam 1C, Waste Rock Stockpile 1) are outside of the maximum floodplain extent, and so will be unaffected. The pre-mining 0.1% AEP event overlaps part of the MIA & CHPP 2 area, as well as the haul road crossing of Deep Creek, but developed modelling shows that development flood levels provides for suitable Project immunity to the 0.1 % AEP event.

The modelling shows that the Project results in minimal changes to the overall flood levels external to the site, the Bruce Highway retains its flood immunity up to the 1% AEP event. No significant increases in flood velocities were identified, with overall geomorphic impacts from the Project on nearby waterways considered low.

Following mining and rehabilitation of the site, some final landforms remain within the floodplain, but all are outside the main channel flood extent of Tooloombah and Deep creeks. Detailed design will be undertaken to include the site drainage system, including over the reinstated final landform, and will be incorporated into the overall Project rehabilitation plan to be presented in the Progressive rehabilitation and closure plan (PRCP).

The mine water balance generally shows that the planned mining and processing water demands will be met by water sourced from catchment rainfall, groundwater dewatering from mining activities, and reuse of water around the site. During drier conditions, there may be some potential shortfalls in water supply. These will be addressed through advanced dewatering and demand management on the site, including production changes such as increasing the amount of coal bypassed (and so reducing the amount to be washed). Pit and dam inventories confirm that there is only a very small risk that the full supply volume of Dam 1 would be reached at some point over the life of the Project, and that both pits can be dewatered effectively over their mining life.

A controlled release strategy has been developed, which aims to reduce the chance of uncontrolled releases occurring and to maintain water levels within the stated operating volumes within the site storages. The modelling has shown that there is a very small risk of an overflow from Dam 1 during the first 10 years of the Project, increasing to around 10% in the latter half of the Project. Other dams maintain a very low risk of overflow over the life of the Project.

Assessment of streamflows in both Deep and Tooloombah Creeks shows that there will be negligible changes to streamflow, and that the highly ephemeral nature of pools, as well as local reliance on bank flow storage and return, rather than baseflow from elevated water table aquifers, will likely have negligible effects on the persistence of pools in general. There could be impacts to pools to the west of Open Cut 2 in Tooloombah Creek, if local water table aquifers are lowered affecting wet season recharge of bank storage. Otherwise, there are not expected to be significant impacts to pools within the Project area.

The site water management system has been configured to manage the different water types on the site, and to selectively contain, store, reuse and treat waters, with dirtier water preferentially reused and clean water diverted around the site. Controlled releases have been designed into the system, which result in very low likelihoods of uncontrolled discharges from the site over the Project life, and result in negligible changes to downstream water quality. Improvements in overall site management from the existing grazing landuse have also been shown to result in a reduction of around 55% in sediment flowing from the site into the downstream environment, with commitments to improving overall riparian vegetation across the Mamelon property adding to stream resilience.

Mitigation has been proposed, and a management and monitoring program provided, detailed in the draft ESCP, the draft Receiving Water Management Plan and draft Water Management Plan, provided with this SEIS (Appendices A15a, A10f and A5c respectively), and summarised in Section 9.7 in this Chapter.

Overall, the assessment has identified that mitigation and management measures can be employed to effectively manage the potential for adverse impacts on the area's surface waters, and that the resultant impacts to the downstream receiving environments will be negligible.

9.11 Commitments

In relation to surface water, Central Queensland Coal's commitments are provided in Table 9-21.

Table 9-21 Commitments – Surface Water

Commitment
Construction of culverts, diversions and watercourse/drainage feature crossings will be undertaken during no-flow periods.
Crossing designs in major impact waterways (i.e. Deep Creek) will comply with State Code 18: Constructing or raising waterway barrier works in fish habitats. All other culvert crossings, not required to comply with State Code 18, adhere to best-practise design for fish passage and Accepted development requirements for operation work that is constructing or raising waterway barrier works.
Implement the proposed water management system in the draft Water Management Plan, the proposed monitoring program in the draft Receiving Environment Monitoring Plan, and the other monitoring proposed in this Chapter. Update both plans following approval and undertake reviews of the adequacy of each and revise as required.
Use monitoring as a continual improvement mechanism for the ongoing management of stormwater including operational calibration of the water balance model.
Update and revise as needed the draft Erosion and Sediment Control Plan (ESCP), including certification by a suitably qualified person, prior to and during both construction and operation.
Minimise unnecessary disturbance to vegetated lands.
Undertake progressive rehabilitation of disturbed areas.
Develop and implement the Progressive Rehabilitation and Closure Plan (PRCP) describing how final landforms associated with the Project will be rehabilitated after mining activities.
Reuse water captured in environmental dams (onsite) and mine dewatering before using raw water, where practicable.

Commitment
Chemical, fuel and temporary liquid waste storage facilities will be constructed and bunded in accordance with the relevant specifications of *AS1940 – Storage and Handling of Flammable and Combustible Liquids* (AS1940)

9.12 IESC Cross-Reference Tables

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (the IESC) is a statutory body under the EPBC Act. The IESC has developed Information Guidelines that outline what types of information a proposal for a CSG or large coal mining project should include. This information is needed to enable the IESC to provide robust scientific advice to government regulators on the potential water-related impacts of such proposals.

The general guidance requirements are addressed variously throughout the SEIS v3. The description of the Project is provided in Chapter 1 – Introduction and Project Description. Risk assessments are provided in each of the technical chapters and reported in the associated technical reports. The descriptions of impacts to water resources and water-dependent assets are, in addition to this Chapter, discussed in detail in Chapter 10 – Groundwater, Chapter 14 – Terrestrial Ecology, Chapter 15 Aquatic Ecology and Chapter 16 – Matters of National Environmental Significance.

Specific information needs relevant to surface water are discussed in Table 9-22 and Table 9-23.

Table 9-22: Surface water - IESC compliance checklist

Question	Yes/No	Comments
Context and conceptualisation		
Describe the hydrological regime of all watercourses, standing waters and springs across the site including: • geomorphology, including drainage patterns, sediment regime and floodplain features. • spatial, temporal and seasonal trends in streamflow and/or standing water levels. • spatial, temporal and seasonal trends in water quality data (such as turbidity, acidity, salinity, relevant organic chemicals, metals, metalloids and radionuclides) and, • current stressors on watercourses, including impacts from any currently approved projects.	Yes	Section 9.3.4 discusses the hydrological regime of all watercourses, standing waters and springs across the site, including Deep Creek, Tooloombah Creek, and the Styx River; geomorphology of the local catchment area and tidal limits. In the absence of historical stream gauging of the site watercourses, hydrological modelling and analysis has been conducted as discussed in Section 9.3.4. The hydrological modelling has been conducted with XP-RAFTS and Australian Water Balance Model (AWBM) to represent both peak floods and daily variability based on long-term historical rainfall records. Baseline water quality is discussed in Section 9.3.6, with further detail provided in the Surface Water Quality Technical Report in Appendix A5a. Current stressors are discussed throughout the chapter, particularly in Section 9.3.6, and cumulative impacts are discussed in Section 9.8.
Describe the existing flood regime, including flood volume, depth, duration, extent and	Yes	Section 9.3.4.4 discusses the hydrology and flood modelling results for the pre-mining

Question	Yes/No	Comments
velocity for a range of annual exceedance probabilities. Provide flood hydrographs and maps identifying peak flood extent, depth and velocity. This assessment should be informed by topographic data that has been acquired using lidar or other reliable survey methods with accuracy stated.		regime, with further detail in the Flood Study and Site Water Balance Technical Report in Appendix A5b. This was based on LiDAR acquired for the Project at a suitable scale, as detailed in Appendix A5b.
Provide an assessment of the frequency, volume, seasonal variability and direction of interactions between water resources, including surface water/ groundwater connectivity and connectivity with sea water.	Yes	Surface water – groundwater interactions have been assessed in a number of specialist reports, including the Surface Water/Groundwater Interactions Report (Appendix A6d), Aquatic Ecology, Groundwater Dependent Ecosystems, Marine Ecology and the Great Barrier Reef (Appendix A10a), Groundwater Dependent Ecosystem Assessment (Appendix A10d) the Surface Water Quality Technical Report (A5a), and in Chapter 10 – Groundwater, based on modelling presented in the Numerical Groundwater Model and Groundwater Assessment Report (Appendix A6b). Surface water – groundwater interactions are incorporated into this chapter in Sections 9.3.4.5 and 9.6.2. Tidal limits are discussed in Section 9.3.4.2.3, and the seawater interface is discussed in Chapter 10 – Groundwater.
Analytical and numerical modelling		
Provide conceptual models at an appropriate scale, including water quality, stores, flows and use of water by ecosystems.	Yes	Discussed in detail in Chapter 10 – Groundwater, with conceptual models of surface – groundwater interactions described in Section 9.3.4.5 in this chapter.
Describe and justify model assumptions and limitations, and calibrate with appropriate surface water monitoring data.	Yes	Flood, rainfall-runoff and water balance models are described and justified in the Flood Study and Site Water Balance Technical Report (Appendix A5b). The modelling used for the surface – groundwater interactions assessment is described in the Surface Water/Groundwater Interactions Report (Appendix A6d). General methods are outlined in Section 9.2 in this chapter.
Use methods in accordance with the most recent publication of Australian Rainfall and Runoff (AR & R) (Ball et al. 2016).	Yes	Detailed in the Flood Study and Site Water Balance Technical Report (Appendix A5b).
Provide an assessment of the risks and uncertainty inherent in the data used in the modelling, particularly with respect to predicted scenarios.	Yes	Detailed in the Flood Study and Site Water Balance Technical Report (Appendix A5b). Flood hydrology adopted the ensemble procedures in AR&R 2019, and a probabilistic approach to climatic conditions in the water balance model.
Develop and describe a program for review and update of the models as more data and information becomes available.	Yes	Section 9.7 incorporates retention and update of the flood and water balance models, including AWBM rainfall-runoff

Question	Yes/No	Comments
		model, post-approval and through development.
Provide a detailed description of any methods and evidence (e.g. expert opinion, analogue sites) employed in addition to modelling.	Yes	Methods are summarised in Section 9.2, including references to the technical reports where relevant.
Impacts to water resources and water-dependent assets		
Describe all potential impacts of the proposed project on surface waters. Include a clear description of the impact to the resource, the resultant impact to any assets dependent on the resource (including water dependent ecosystems such as riparian zones and floodplains), and the consequence or significance of the impact. Consider: • impacts on streamflow under the full range of flow conditions. • impacts associated with surface water diversions. • impacts to water quality, including consideration of mixing zones. • the quality, quantity and ecotoxicological effects of operational discharges of water (including saline water), including potential emergency discharges, and the likely impacts on water resources and water-dependent assets. • landscape modifications such as subsidence, voids, post rehabilitation landform collapses, on-site earthworks (including disturbance of acid-forming or sodic soils, roadway and pipeline networks) and how these could affect surface water flow, surface water quality, erosion, sedimentation and habitat fragmentation of water dependent species and communities.	Yes	Section 9.5 discusses the potential impacts on water resources, with Section 9.6 providing the impact assessment. Impacts to groundwater dependent assets are discussed in Chapter 10 – Groundwater and Chapters 14 - Terrestrial Ecology (terrestrial GDEs) and Chapter 15 - Aquatic and Marine Ecology (aquatic and subterranean GDEs).
Discuss existing water quality guidelines, environmental flow objectives and requirements for the surface water catchment(s) within which the development proposal is based.	Yes	Section 9.3.6
Identify processes to determine surface water quality guidelines and quantity thresholds which incorporate seasonal variation but provide early indication of potential impacts to assets.	Yes	Section 9.2.3 summarises the methods used, with the detail provided in the Surface Water Quality Technical Report in Appendix A5a.
Propose mitigation actions for each identified significant impact.	Yes	Section 9.7.
Describe the adequacy of proposed measures to prevent or minimise impacts on water resources and water-dependent assets.	Yes	Section 9.7 discusses the adequacy of the proposed measures, and methods to evaluate if impacts are or may be occurring. Additional discussion is presented in Chapter 10 - Groundwater.

Question	Yes/No	Comments
Describe the cumulative impact of the proposal on surface water resources and water-dependent assets when all developments (past, present and reasonably foreseeable) are considered in combination.	Yes	The cumulative surface water related impacts that may be associated with the proposed Project are discussed in Section 9.8.
Provide an assessment of the risks of flooding (including channel form and stability, water level, depth, extent, velocity, shear stress and stream power), and impacts to ecosystems, project infrastructure and the final project landform.	Yes	Section 9.6.1 provides the flooding assessment, and Section 9.6.4 includes an assessment of erosion and sedimentation and geomorphological impacts. The Flood Study and Site Water Balance Technical Report (Appendix A5b) and the Supplementary Technical Study Report, Fluvial Geomorphology (Appendix A5d) detail the assessments.
Data and monitoring		
Identify monitoring sites representative of the diversity of potentially affected water dependent assets and the nature and scale of potential impacts, and match with suitable replicated control and reference sites (BACI design) to enable detection and monitoring of potential impacts.	Yes	Section 9.7.7 and the draft Receiving Environment Monitoring Plan (Appendix A10f)
Develop and describe a surface water monitoring program that will collect sufficient data to detect and identify the cause of any changes from established baseline conditions, and assess the effectiveness of mitigation and management measures. The program will: • include baseline monitoring data for physico-chemical parameters, as well as contaminants (e.g. metals). • comparison of physico-chemical data to national/regional guidelines or to site specific guidelines derived from reference condition monitoring if available and, • identify baseline contaminant concentrations and compare these to national guidelines, allowing for local background correction if required.	Yes	Section 9.7.7 and the draft Receiving Environment Monitoring Plan (Appendix A10f)
Ensure water quality monitoring complies with relevant National Water Quality Management Strategy (NWQMS) guidelines (ANZG 2018) and relevant legislated state protocols (e.g. EHP 2013).	Yes	Section 9.7.7 and the draft Receiving Environment Monitoring Plan (Appendix A10f)
Describe the rationale for selected monitoring parameters, duration, frequency and methods, including the use of satellite or aerial imagery to identify and monitor largescale impacts.	Yes	Section 9.7.7 and the draft Receiving Environment Monitoring Plan (Appendix A10f)
Identify data sources, including streamflow data, proximity to rainfall stations, data record duration and describe data methods, including whether missing data have been patched.	Yes	Section 9.7.7 and the draft Receiving Environment Monitoring Plan (Appendix A10f).

Question	Yes/No	Comments
		A detailed assessment of the baseline data is provided in the Surface Water Quality Technical Report in Appendix A5a. The existing water quality database will continue to be updated with new data as it arrives and is subjected to data quality assessments.
Develop and describe a plan for ongoing ecotoxicological monitoring, including direct toxicity assessment of discharges to surface waters where appropriate.	Yes	Section 9.7.7 and the draft Receiving Environment Monitoring Plan (Appendix A10f).
Identify dedicated sites to monitor hydrology, water quality, and channel and floodplain geomorphology throughout the life of the proposed project and beyond.	Yes	Section 9.7.7 and the draft Receiving Environment Monitoring Plan (Appendix A10f). Geomorphological monitoring is provided in the Supplementary Technical Study Report, Fluvial Geomorphology in Appendix A5d, and monitoring for the water management system in the Draft Water Management Plan in Appendix A5c. These are summarised in Section 9.7.7 in this chapter.

Table 9-23: Water balance - IESC compliance checklist

Question	Yes/No	Comments
Is a quantitative site water balance model provided, that describes the total water supply and demand under a range of rainfall conditions and allocation of water for mining activities (e.g. dust suppression, coal washing etc.), including all sources and uses?	Yes	Detailed in the Flood Study and Site Water Balance Technical Report in Appendix A5b, and summarised in this chapter (Sections 9.2.5, 9.2.5, 9.2.7, 9.4 and 9.6.3).
Are estimates provided of the quality and quantity of operational discharges under dry, median and wet conditions, potential emergency discharges due to unusual events and the likely impacts on water-dependent assets?	Yes	Detailed in the Flood Study and Site Water Balance Technical Report in Appendix A5b, and summarised in this chapter in Section 9.6.3).
Describe the water requirements and on-site water management infrastructure, including modelling to demonstrate adequacy under a range of potential climatic conditions.	Yes	Detailed in the Flood Study and Site Water Balance Technical Report in Appendix A5b, and summarised in this chapter in Sections 9.4 and 9.6.3).
Provide salt balance modelling that includes stores and the movement of salt between stores, and takes into account seasonal and long-term variation.	Yes	Detailed in the Flood Study and Site Water Balance Technical Report in Appendix A5b, and summarised in this chapter in Section 9.6.5.